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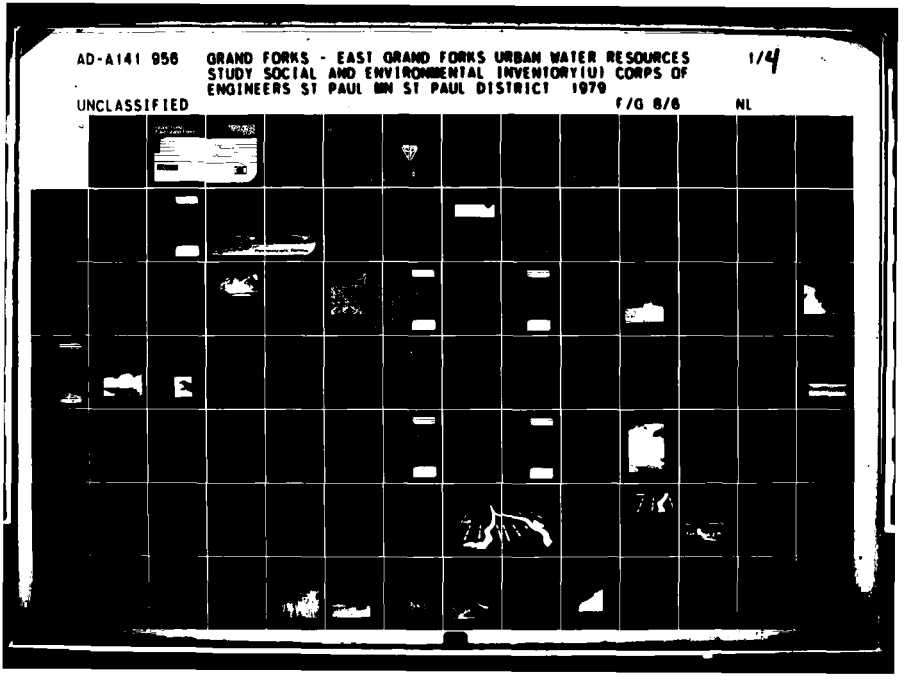

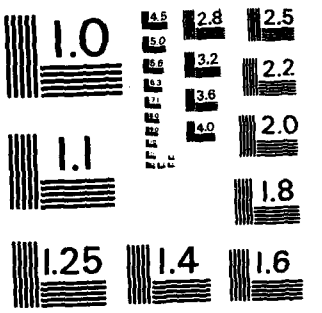

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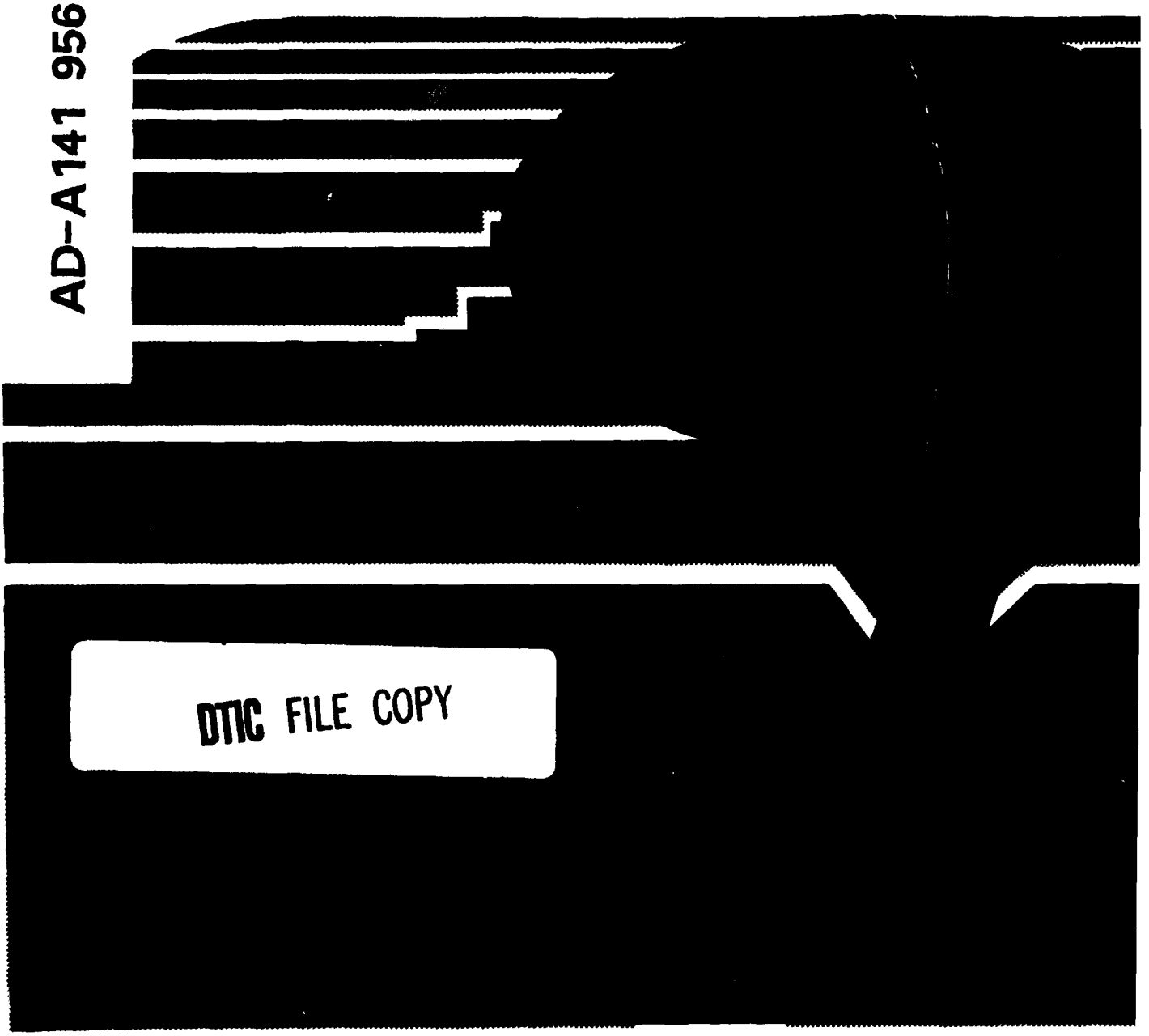

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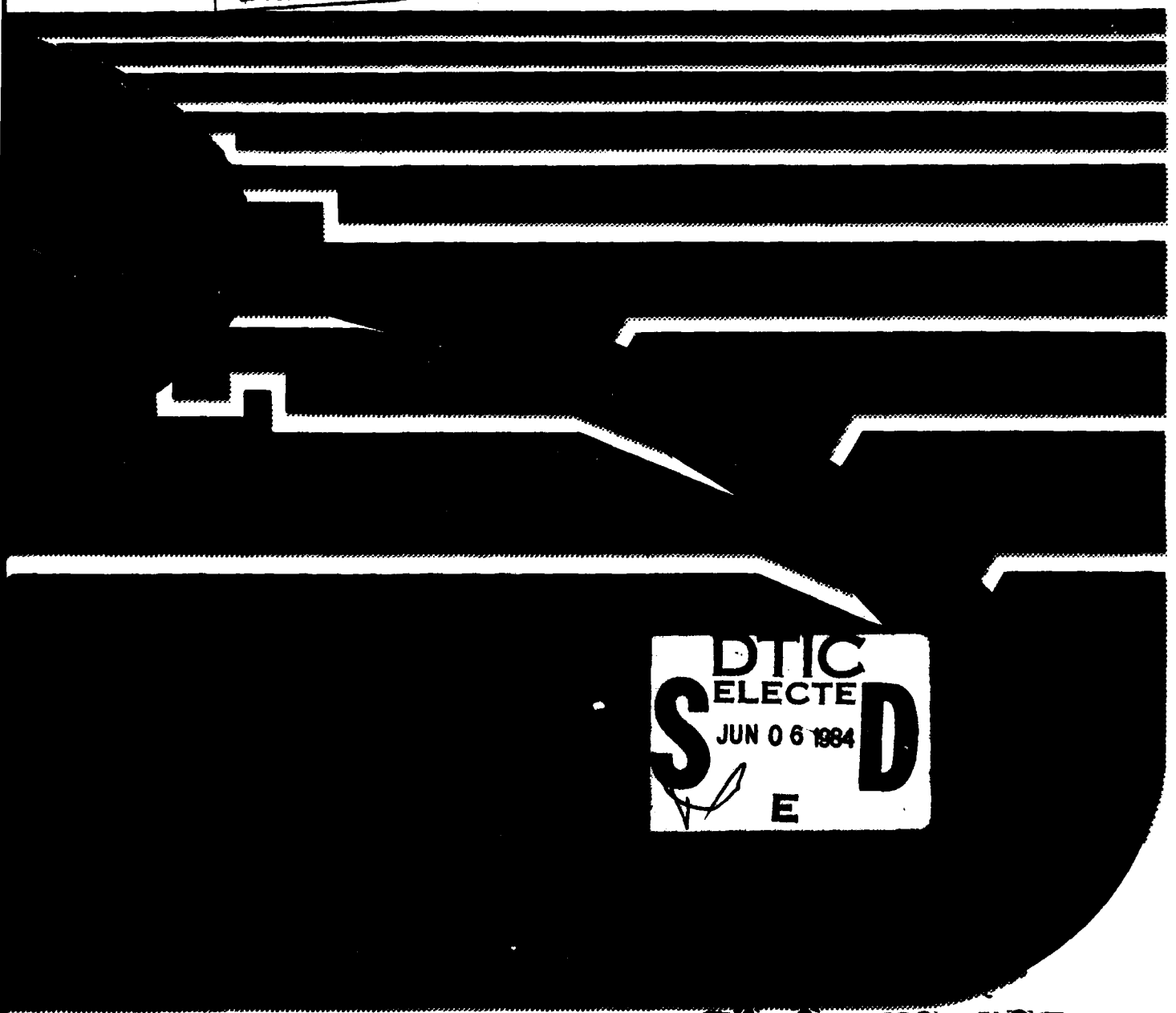

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URBAN PLANNING

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report is part of the urban study of Grand Forks-East Grand Forks metropolitan area, and is designed to aid the project planning and assessment by providing an inventory of base line data on a comprehensive list of social and environmental factors. Included in this inventory report is a compendium of facts and figures about the physiographic, biological and cultural elements within the Grand Forks-East Grand Forks area. The base line data were compiled from field reconnaissances, published sources, work soon to be published and from interviews with knowledgeable individuals.

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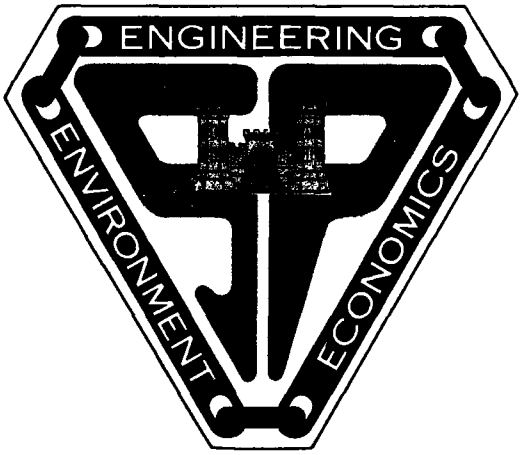
DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1135 U. S. POST OFFICE & CUSTOM HOUSE
ST. PAUL, MINNESOTA 55101

We are currently conducting the Grand Forks-East Grand Forks Urban Water Resources Study. The study, scheduled for completion in 1980, will identify existing water resource problems in the Grand Forks-East Grand Forks urban study area, project water resource needs, and provide alternative plans and programs required to best meet those needs.

Early in the study, we contracted with Wehrman, Chapman Associates, Inc., Minneapolis, Minnesota, for preparation of this Social and Environmental Inventory Report. The report represents a first attempt to gather available background information on selected physiographic, biological, cultural, and economic aspects of the study area. This information will assist us in defining local problems and needs and in creating and evaluating alternative water and related land resource development plans. We trust that the report will also be helpful in future planning studies for the area.

Forrest T. Gay III

FORREST T. GAY, III
Colonel, Corps of Engineers
District Engineer



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FOREWORD

Introduction

This report is part of the Urban Study of the Grand Forks-East Grand Forks metropolitan area and is designed to aid the project planning and assessment by providing an inventory of base line data on a comprehensive list of social and environmental factors. Included in this inventory report is a compendium of facts and figures about the physiographic, biological and cultural elements within the Grand Forks-East Grand Forks area.

Selected in close cooperation with local interests, the study area includes, as shown on the following location map, the major cities of Grand Forks and East Grand Forks, four adjacent townships in Polk County, Minnesota, and the portion of Grand Forks County, North Dakota, extending south to Thompson, north to Manvel, and west to Arvilla, North Dakota.

Determining what is within the boundaries of the study area and the value of these elements is the first major step in the project planning and assessment process. The information from this initial investigation sets the planning criteria and begins to establish the impacts that would result from the project. A large and growing list of governmental agencies, groups and individuals must be contacted to obtain this information. From these numerous contacts, data must be collected on such diverse topics as historic sites, social characteristics and wildlife habitat. Data acquisition often requires a large percentage of the time allocated to the total planning and assessment effort. By providing this base line inventory, it is anticipated that the amount of time spent on the investigation of a project area can be reduced and that more time can be spent in developing the project plan and in determining the magnitude and results of the project's impacts.

Report Format

The base line data provided in this report were compiled from field reconnaissances, published sources, work soon to be published and from interviews with knowledgeable individuals. The collection of new data was not part of this project.

To maximize the usefulness of the report, most of the base data is contained in displays rather than in a general text. Where appropriate, information has been mapped for quick spatial reference. Tables and listings of key published references augment mapped data.

The information in this report was not selected to be of specific interest to the specialists within a discipline. The information in this report can only be considered as first cut or very basic data. An effort was made to make the depth of information on each element consistent throughout the report, with reference to sources of more explicit information provided for those requiring more detailed data.

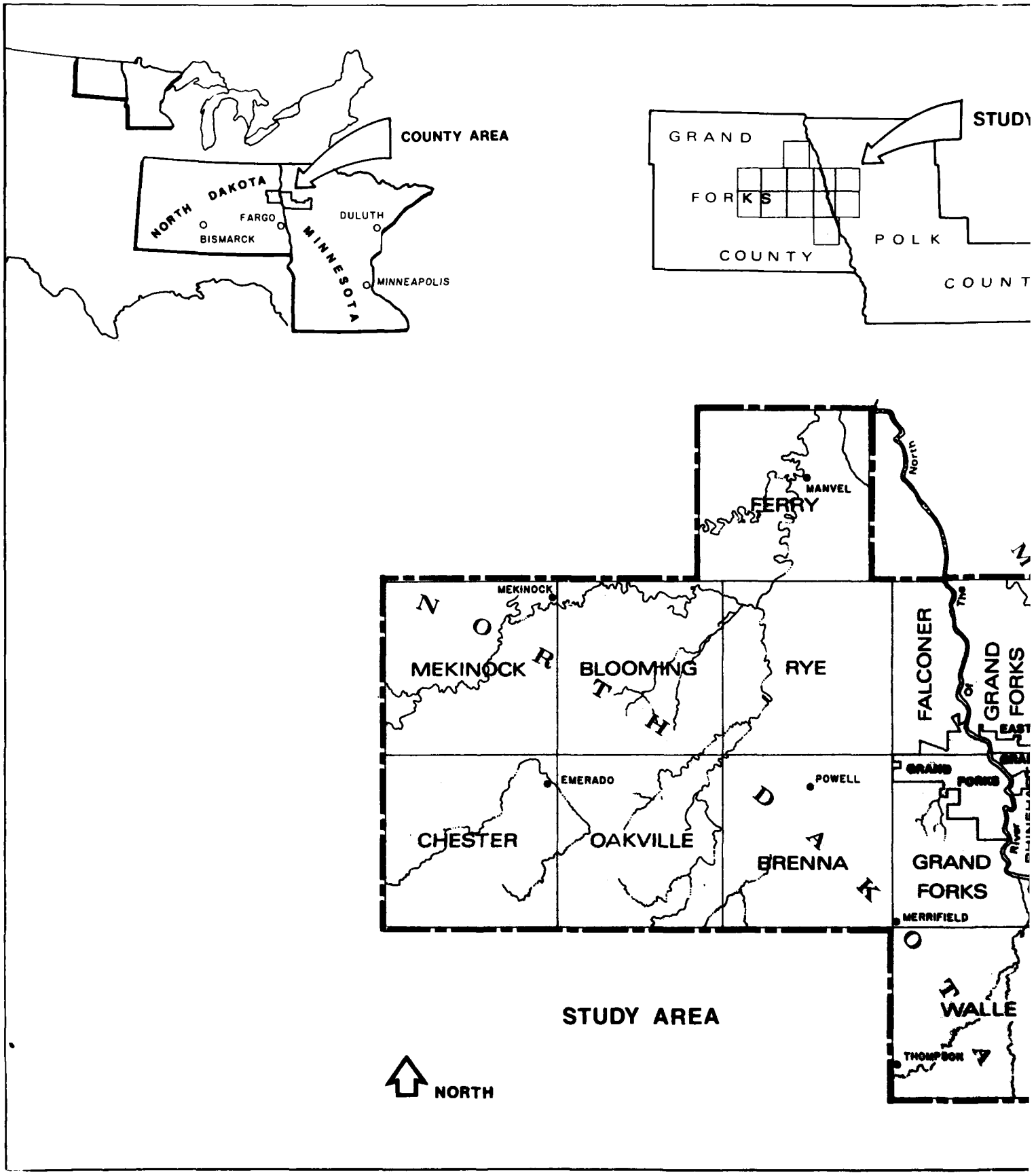
Report Content

The report is divided into three sections. The first deals with the physiography or physical geography of the region. The interactions of geology, soils, mineral resources, water resources and climate form a base upon which the human activity and natural ecosystems of the region are built. Knowledge of these factors is most important for understanding basic problems associated with natural and human environments. Data such as geologic structure and types of soils, existence of mineral resources and availability of water are important in developing the framework for project planning and assessment, and have been included in this report.

The second general category deals with the natural environment. This section includes the definition of the region's basic ecosystems, a listing of various wildlife species, enumeration of important and unique environmental areas and a list of threatened or endangered species.

The final section deals with the human cultural elements and is further divided into two subsections. The first is concerned with historical elements such as archeology and the history of the area. The second is concerned with the society of the region, including demographic characteristics, the general location of transport modes, type and location of community facilities, recreational facilities, and industrial and commerical activity.

Socioeconomic data for the Grand Forks-East Grand Forks area includes general demographic characteristics, government operations and "political" or citizen organizations. The demographic data include age, income, population density and education levels taken from 1970 census data. Information on school districts, general tax levies and citizen-neighborhood groups has been included to complete the picture of the cultural base of the area.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DULUTH
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STUDY
MANVEL
FERRY
MEKINOCK
BLOOMING
RYE
FALCONER
GRAND FORKS
EMERADO
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STUDY AREA
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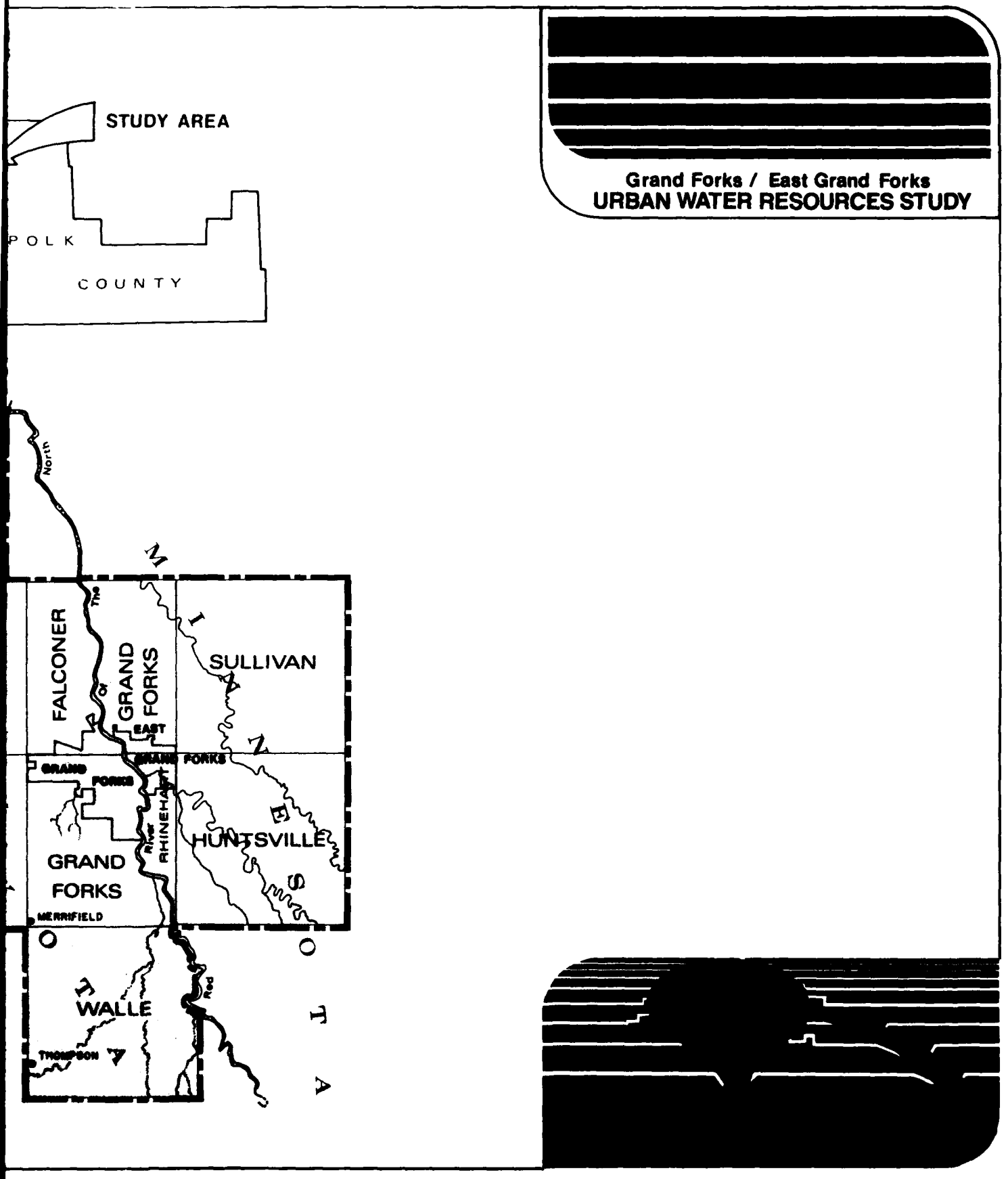
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Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY
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WALLE
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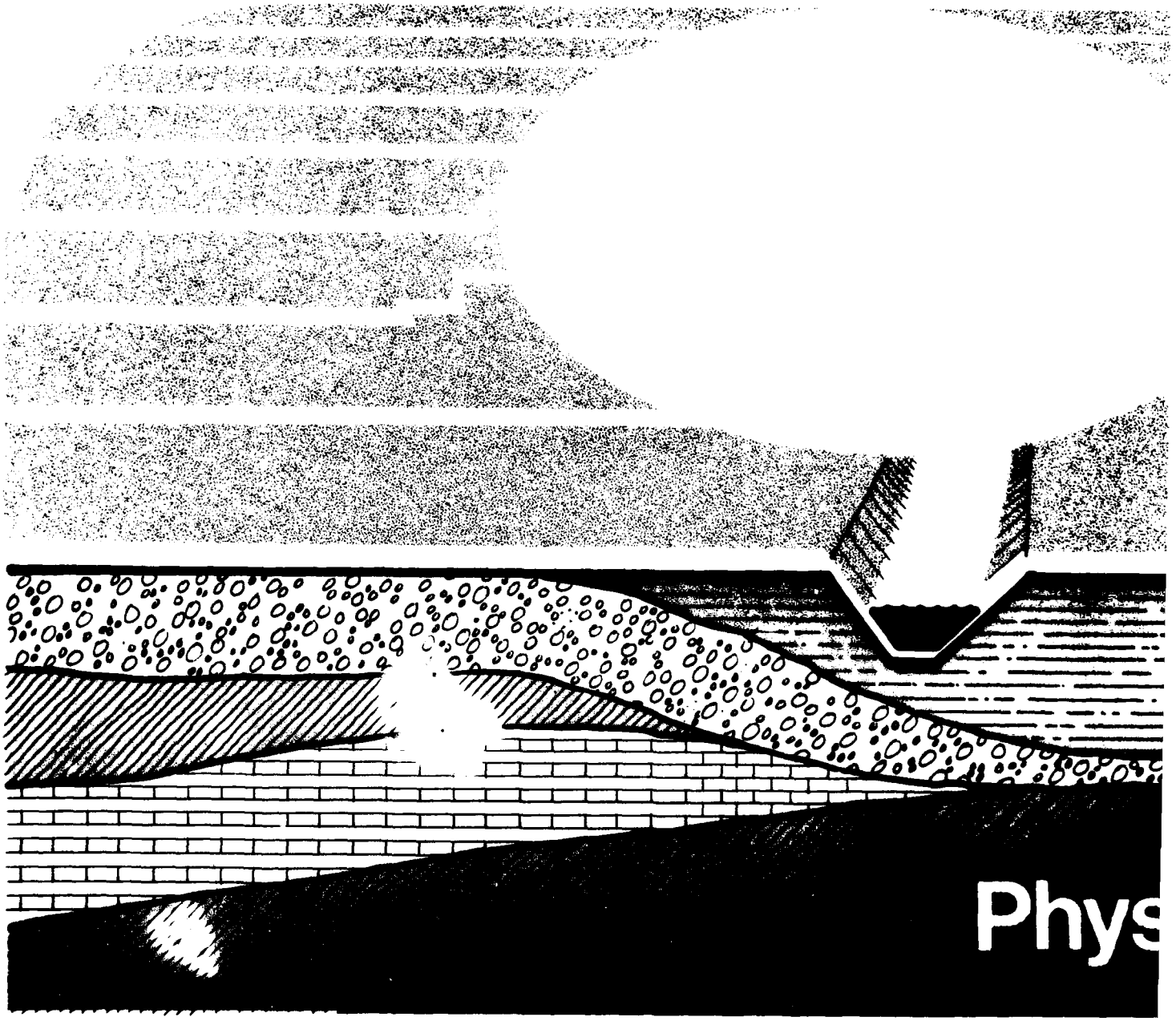
Grand Forks
East Grand Forks



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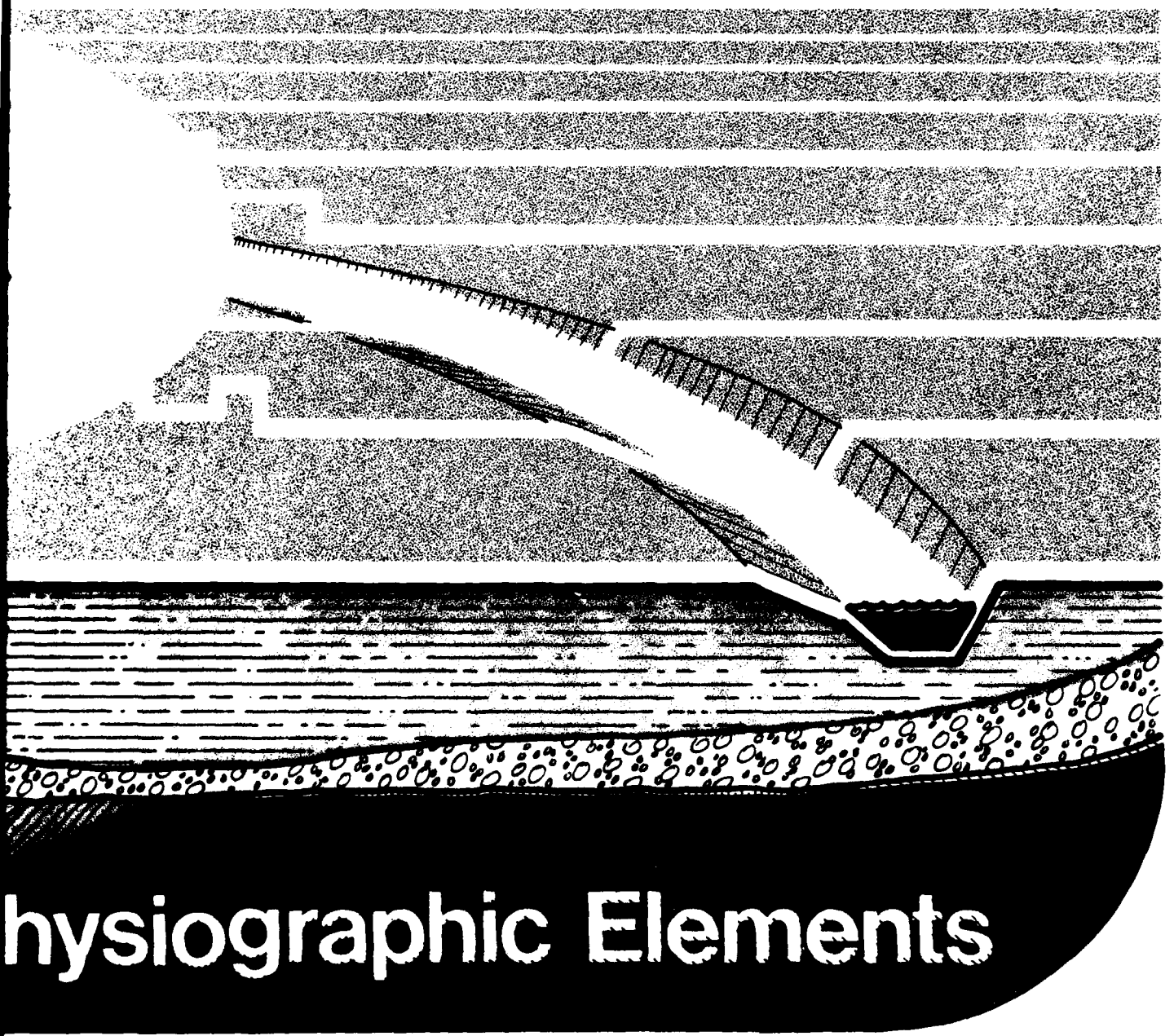

hysiographic Elements

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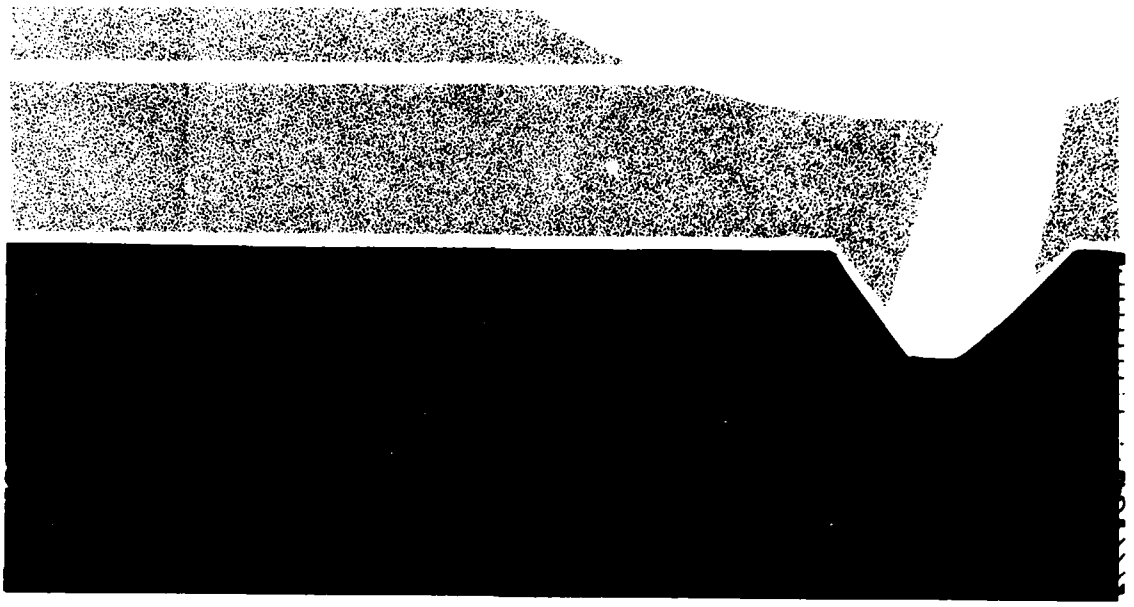


PHYSIOGRAPHIC ELEMENTS

Geology

Mineral Resources

Soils

Water Resources

Climate

INTRODUCTION

The present physiography of the Grand Forks-East Grand Forks area (Figure 1) clearly shows evidence of past glacial epochs. Not so evident, however, are the buried remains of an era over 100 million years ago when the area was periodically invaded by the seas. The deposition of sediments and animal life in these ancient seas over a vast period of time formed the layers of limestones, shales and sandstones overlying the deeply buried Precambrian bedrock.

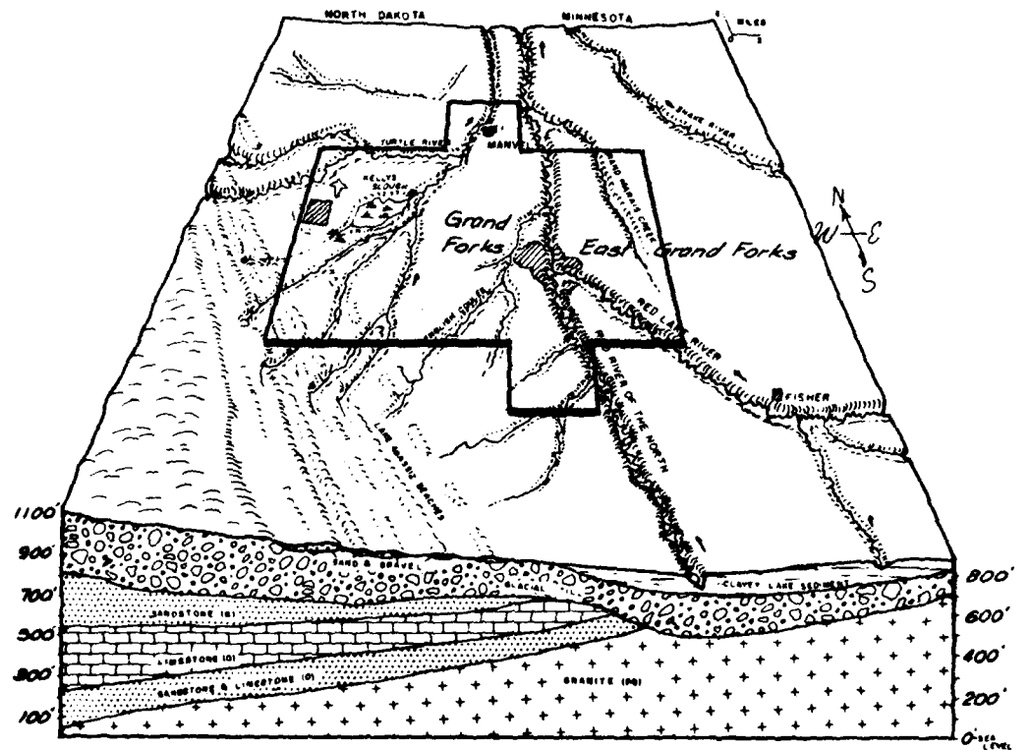


FIGURE 1

PHYSIOGRAPHIC MAP OF GRAND FORKS - EAST GRAND FORKS AREA SHOWING SUBSURFACE STRATIGRAPHY

SOURCE: REFERENCE NO. 1

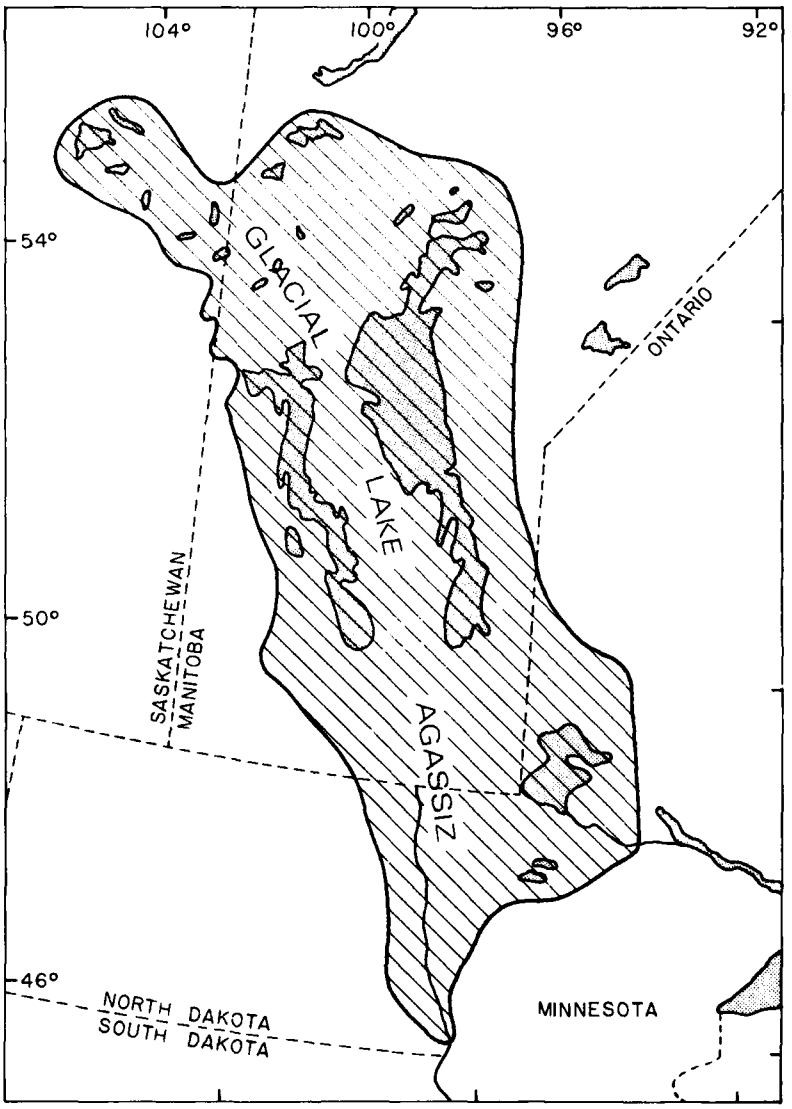


FIGURE 2

GLACIAL LAKE AGASSIZ
ITS EXTENT AT HIGHEST WATER STAGE

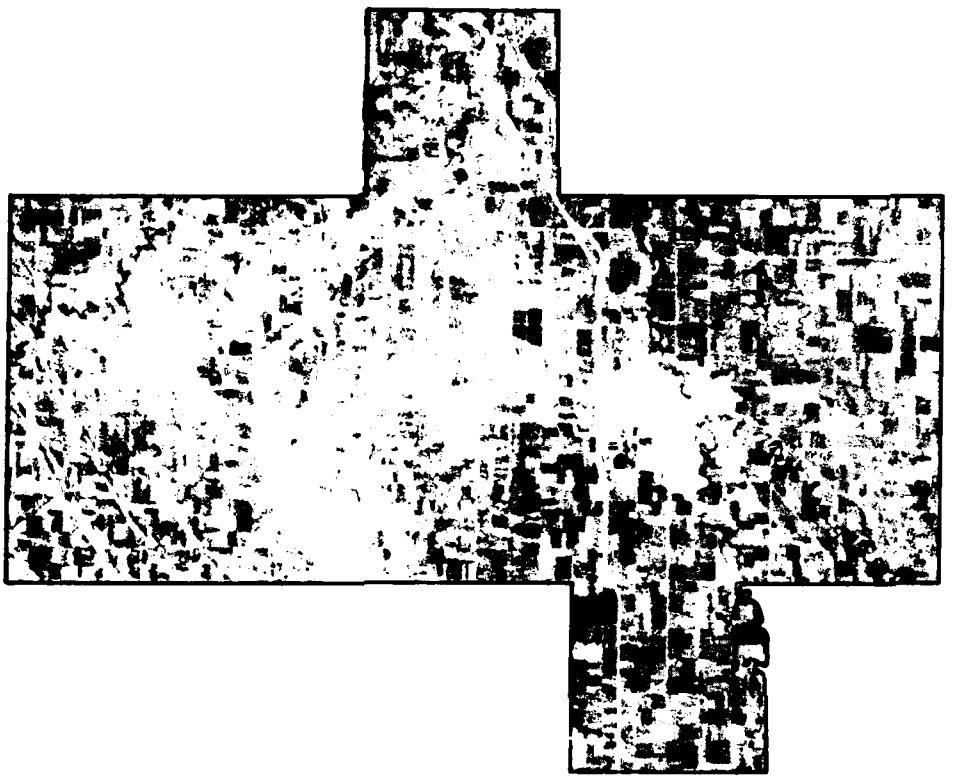
SOURCE: REFERENCE NO. 5

Extensive change to this preglacial landscape began with the invasion of the continental ice sheets almost one million years ago. Of most significance to the area were the glacial actions during the early and late Wisconsinan period, between 70,000 and about 10 to 12,000 years ago. The moraines, outwash plains (Elk Valley) and other deposits in western Grand Forks and west central Polk Counties provide visual evidence of these glacial movements.

The last glacier receded from the area about 10 to 12,000 years ago, followed by formation of glacial Lake Agassiz and associated land forms. At its maximum elevation, this glacial lake covered large portions of eastern North Dakota, northwestern Minnesota, and the Canadian Province of Manitoba. Clear evidence of this ancient lake is seen in the distinct former beach ridges extending in a north-south direction west of Emerado in Grand Forks County, and in a similar direction in west central Polk County. The pattern of five major beach ridges in Grand Forks County represents successive lake elevations as the lake reached its maximum level, covering about 7,000 square miles in the two-state area (Figure 2), then dropped as an outlet was found to the Minnesota River Valley, arose again, and finally drained altogether from the area. What was the former lake bottom is now the very flat, agriculturally productive Red River Valley.

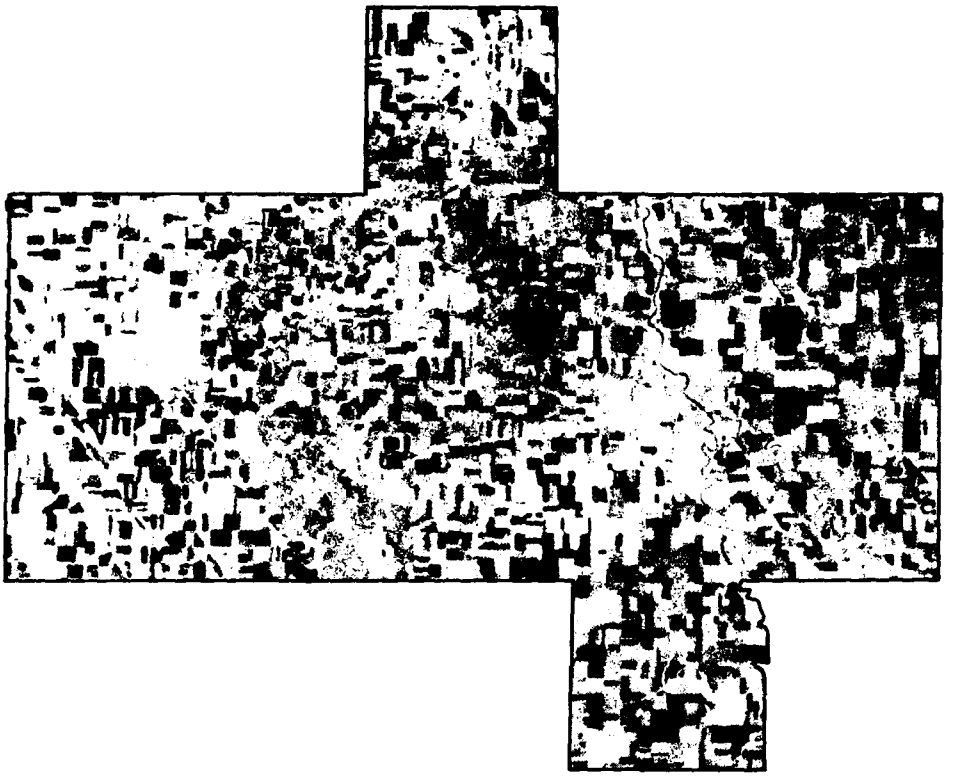
The topography, location and geologic structure of the Grand Forks-Polk County region place the area in the Central Lowland Province and Western Young Drift Section. Within these region-wide classifications, the Grand Forks-East Grand Forks study area lies within the Agassiz Lake Plain District, which is further subdivided in Grand Forks County into the Manvel Lowland Area, Arvilla Slope Area and Elk Valley Outwash Area. The principal features of the area are the distinct former beach ridges bordering the very flat lake plain.

Topographic relief in the lake plain area usually does not exceed 5 feet, with almost imperceptible land slopes toward the Red River in both counties. The terrain in Grand Forks County slopes from about 1060 to 1070 feet above sea level in the western sector, generally northeastward, to about 800 feet in the northeastern part of the county. Drainage in the area is generally poor. Intermittent streams from the higher plain, together with numerous ditches constructed over the years, extend this drainage to the Red River.



EARTH RESOURCES TECHNOLOGY SATELLITE (LANDSAT) IMAGERY
RED BAND SHOWING CULTURAL FEATURES

The Red River of the North, Red Lake River and underground beach ridge aquifers are the most important water resources in the area. Natural lakes are nonexistent in the lake plain study area. Although of beneficial use as an area water supply source, the Red and Red Lake Rivers have periodically resulted in disastrous damages due to rampaging floods. Man has partially succeeded in measures to reduce adverse flood effects in localized areas in the basin, but vast areas of productive farmland and some developed areas remain subject to extensive flooding.



EARTH RESOURCES TECHNOLOGY SATELLITE (LANDSAT) IMAGERY INFRA RED BAND SHOWING WATER RESOURCES & VEGETATION

The floodplain at Grand Forks-East Grand Forks is about 0.6 mile wide and the Red Lake River floodplain is approximately 0.5 mile in width. Floodplains of the lesser streams range from about 0.5 mile along the Turtle River at Manvel to about 1 to 2,000 feet for English Coulee at Grand Forks.

GEOLOGY

During the Pleistocene era, periodic glacial actions over a period of about 70,000 years established what would eventually become one of the most productive agricultural areas in the world - the Red River basin. At least three and possibly four glaciers moved southward over the area. Each successive advance and recession of the ice sheets eroded the higher areas and filled the lower areas with glacial drift. Thickness of the glacial drift varies from about 300 feet in western Polk County to a maximum of about 450 feet in Grand Forks County.

About 12,000 years ago, the last of the glaciers melted and receded northward from the area. Starting out as a smaller lake between the final and terminal moraine and the melting edge of the glacier, Lake Agassiz eventually covered a large area (see Figure 2) and reached a depth such that 330 feet of water covered what is now the Grand Forks-East Grand Forks area. The maximum elevation, and subsequent lower lake elevations as the lake later drained to the south through the Minnesota River Valley, are clearly evidenced by the remaining beach ridges in the Grand Forks study area (see Figure 1) and western Polk County. Maximum depth of Lake Agassiz sediments, clay and silt, is about 95 feet. Thus, the principal unique geologic features in the study area include the flat lake plain bordered by the series of beach ridges.

The subsurface formations underlying the study area are comprised primarily of igneous and metamorphic rocks of the Precambrian age of several hundred million years ago (see Figure 3). Surface elevations of this bedrock vary from about 550 feet and 400 feet respectively in the eastern and western portions of the study area. Overlying these Precambrian era rocks are the sedimentary rocks of the Paleozoic and Mesazoic ages, and include the Ordovician (principally shales and limestones), Jurassic (siltstones and sandstones), Cretaceous (claystones and siltstones interbedded with sandstones), and Quatenary or glacial drift deposits. Depths of the Ordovician and Cretaceous systems under the Grand Forks County study area vary from around 800 feet to less than 20 feet from west to east, as shown in Figure 4. Information on specific depths of these systems on the Minnesota side of the river is not available, but depths of 20 to 50 feet are considered reasonable estimates. The location and extent of non-glacial land forms is shown on Plate 1. A topographic map

which clearly shows the flat former lake bed bordered by the north-south beach ridges is shown on Plate 2.

The United States Geological Survey indicates that no geological hazards exist in the study area.

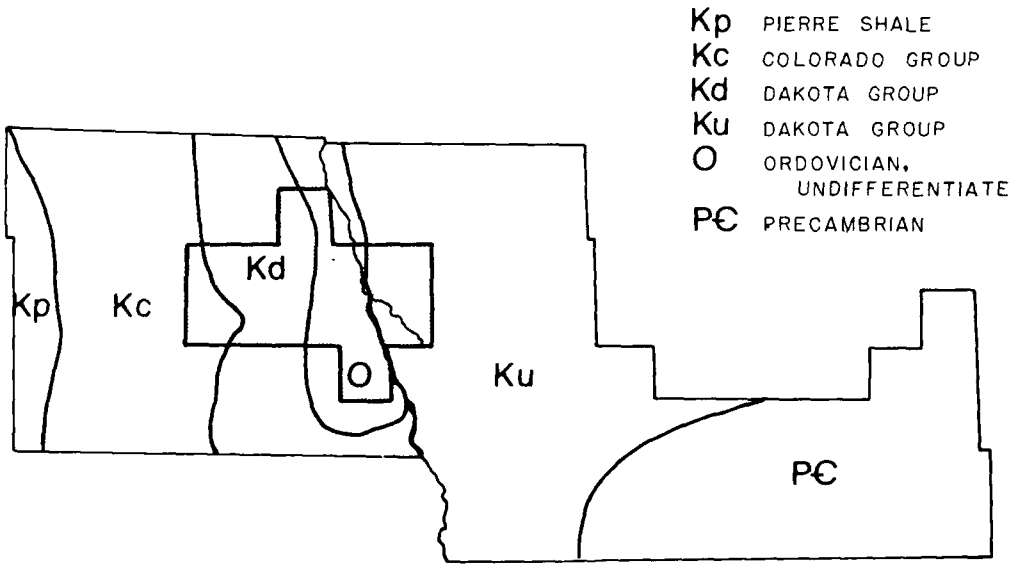


FIGURE 3

GEOLOGIC BEDROCK MAP
OF GRAND FORKS AND POLK COUNTIES

SOURCE: REFERENCE NO. 1 & 18

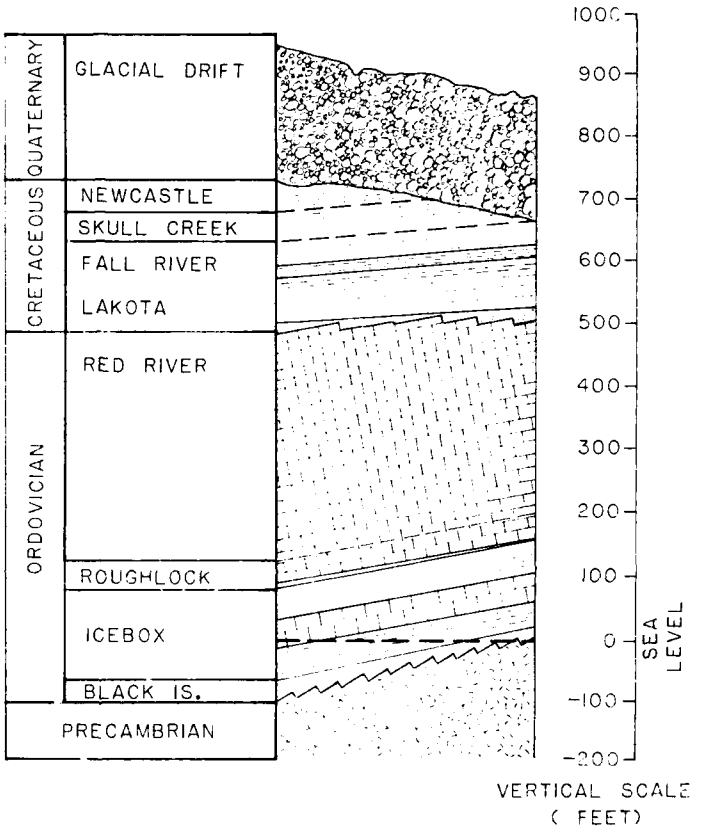


FIGURE 4

GENERAL STRATIGRAPHIC COLUMN OF GRAND FORKS COUNTY

SOURCE: REFERENCE NO. 1

KEY REFERENCES

North Dakota Geological Survey, **Geology and Ground Water Resources of Grand Forks County,** Part I - Geology, Bulletin 53, 1970

North Dakota Geological Survey, **Geology and Ground Water Resources of Grand Forks County,** Part III - Ground Water Resources, Bulletin 53, 1970

Sims, P.K. and Morey, G.B., **Geology of Minnesota: A Centennial Volume,** Minnesota Geological Survey, 1972

Simmons, W.H., et. al., **Geology - Principles and Processes,** McGraw-Hill Book Company, Inc., 1955

U. S. Geological Survey, **Selected Topographic Quadrangle Maps, Manvel, Grand Forks, Mallory, Thompson, Arvilla, Emerado, Gilby and Oslo,** 1963 through 1973 editions

MINERAL RESOURCES

Sand and gravel are the only mineral resource in Grand Forks and Polk Counties. Little is shipped out of the area and production is geared to the amount of construction occurring in the area.

The sand and gravel in these counties is of glacial origin. Glaciofluvial sand and gravel occur in stream channels, glacial meltwater trenches and glacial outwash plains. Glaciolacustrine sand and gravel occur in deltas and various Lake Agassiz shore deposits, which include beaches and bars. Table I provides a list of sand and gravel production values in each county for the years 1967-1972. Locations of sand and gravel pits within the study region are shown on Plate 1. Investigations and explorations have been made, primarily in Grand Forks County, to develop additional mineral resources. Seven exploratory oil wells were drilled but no oil shows were reported in any of the wells. In western Grand Forks County, outcrops of bentonite clay beds occur in some roadcuts and ravines. This clay is of a calcium

and magnesium type better known as "Fuller's Earth," a natural bleaching powder. The clay is used for bleaching mineral, vegetable and animal oil, and as a binder for taconite pelletizing. However, at the present time, the bentonite clays of Grand Forks County are not mined in significant quantities.

TABLE I

SAND AND GRAVEL PRODUCTION
GRAND FORKS AND POLK COUNTIES

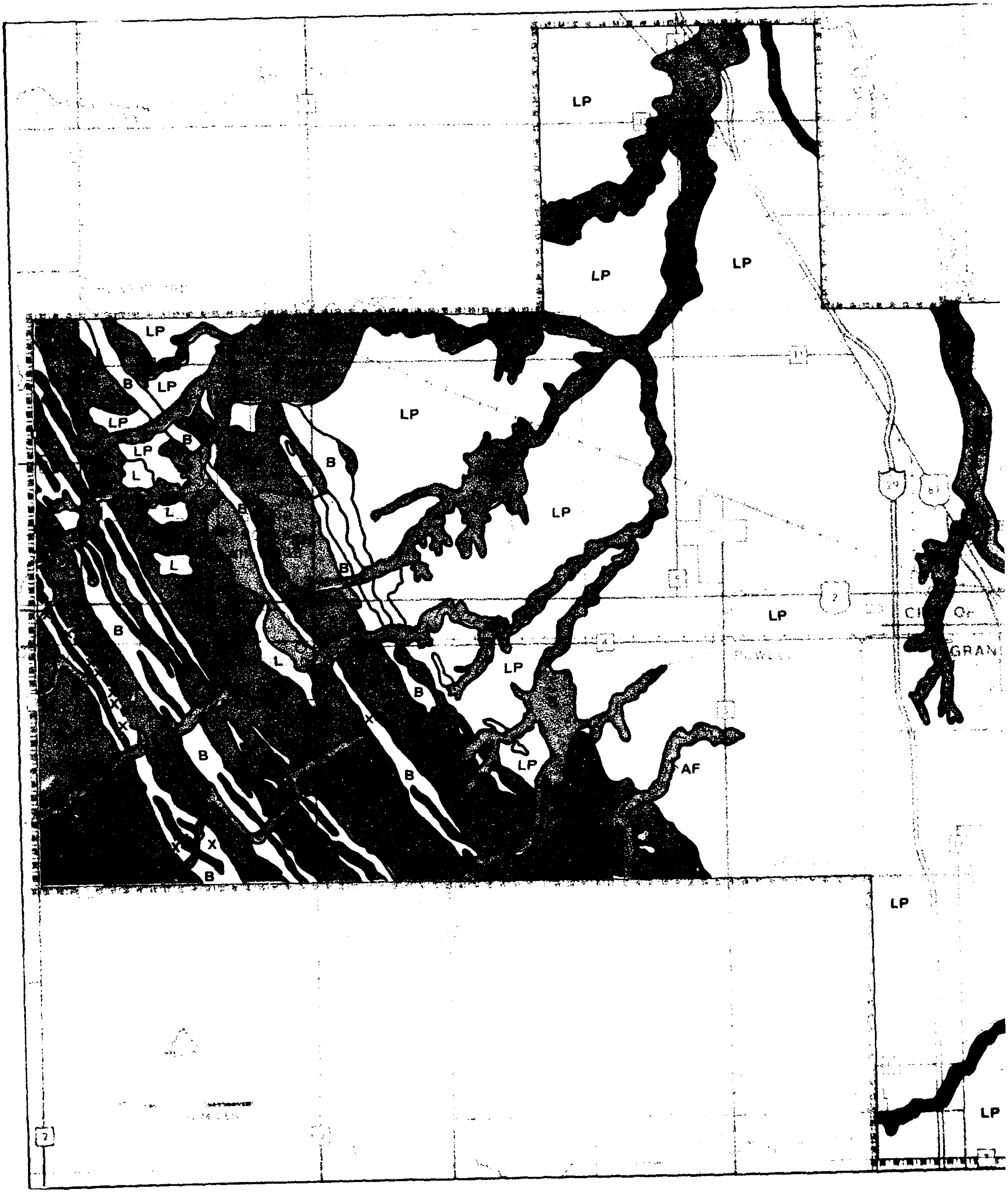
	POLK COUNTY		GRAND FORKS COUNTY	
Year	Quantity[1]	Value[2]	Quantity[1]	Value[2]
1972	813	771	W	114
1971	881	832	W	334
1970	1088	933	W	568
1969	989	W	W	451
1968	1248	W	W	494
1967	637	W	W	444

1 - Thousands of short tons
2 - Thousands of dollars
W - Withheld to avoid disclosing individual company confidential data

KEY REFERENCES

Sims, Paul K., **Directory of Minnesota Mineral Producers 1962,** Information Circular Number 1, University of Minnesota, 1964

U.S. Department of the Interior, Bureau of Mines, **Minerals Yearbook,** Government Printing Office, Washington, D.C., 1969-1974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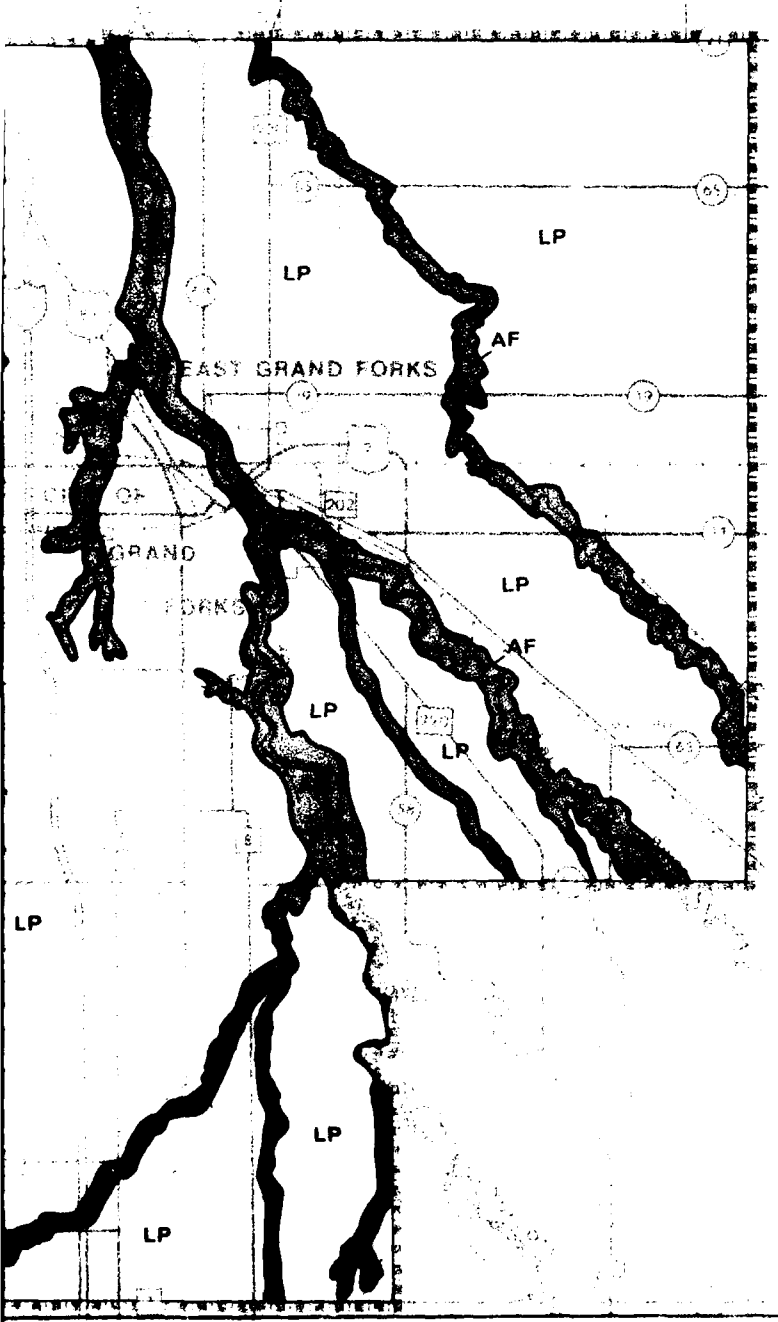
Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

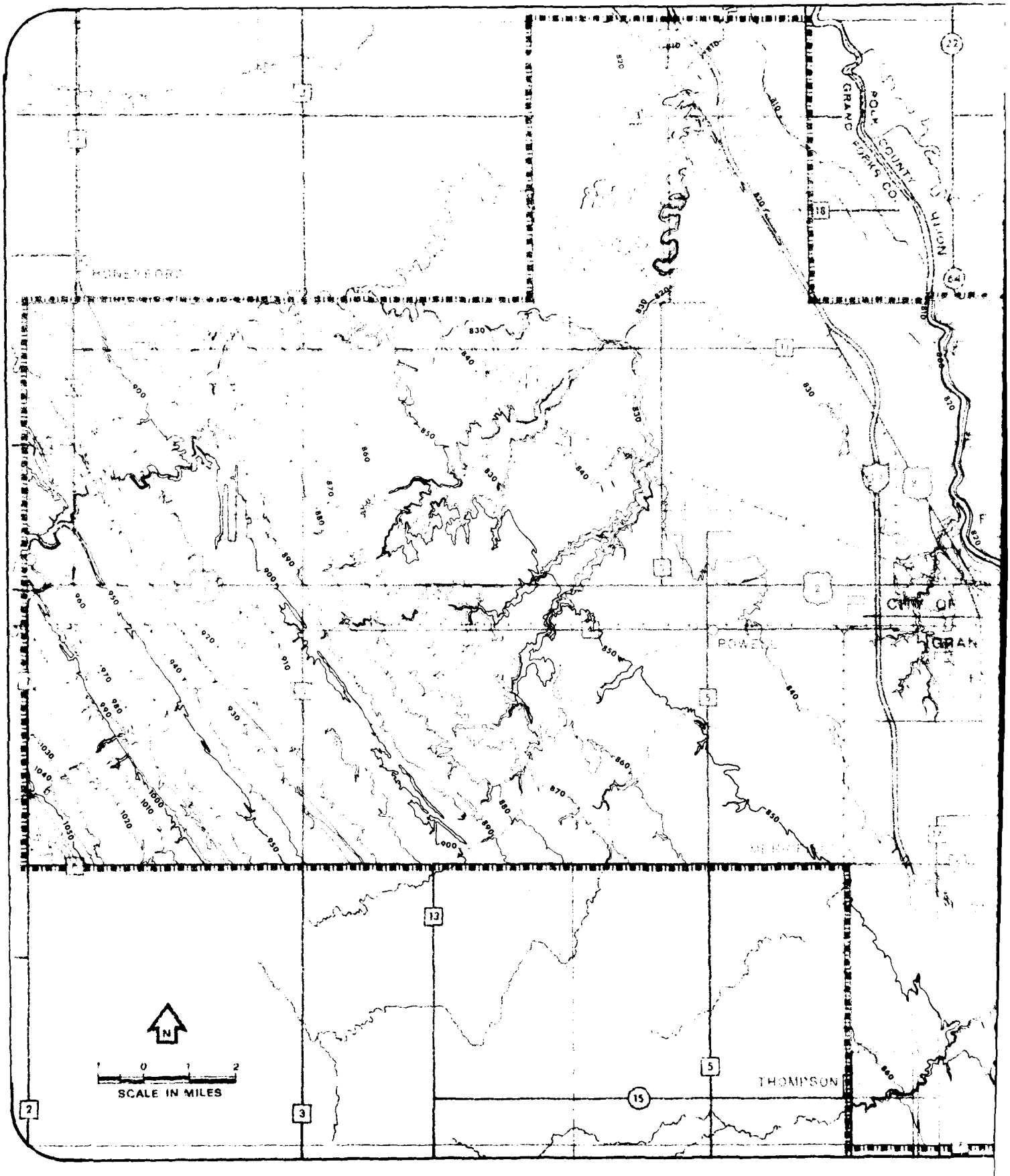


NON-GLACIAL LANDFORMS

- ALLUVIUM (FLOODPLAIN)
- SHORE DEPOSITS
- DELTAIC DEPOSITS
- SWAMP DEPOSITS
- B — BEACH DEPOSITS
- LP — LAKE DEPOSITS (PLAIN)
- L — LAKE DEPOSITS
- GROUND MORAINE, WATERWORN
- X — SAND AND GRAVEL PIT

SOURCE: REFERENCES 1,4,15,18,46.

PLATE 1


POLK COUNTY
GRAND FORKS CO.
HUMBOLDT
POWERS
CITY OF
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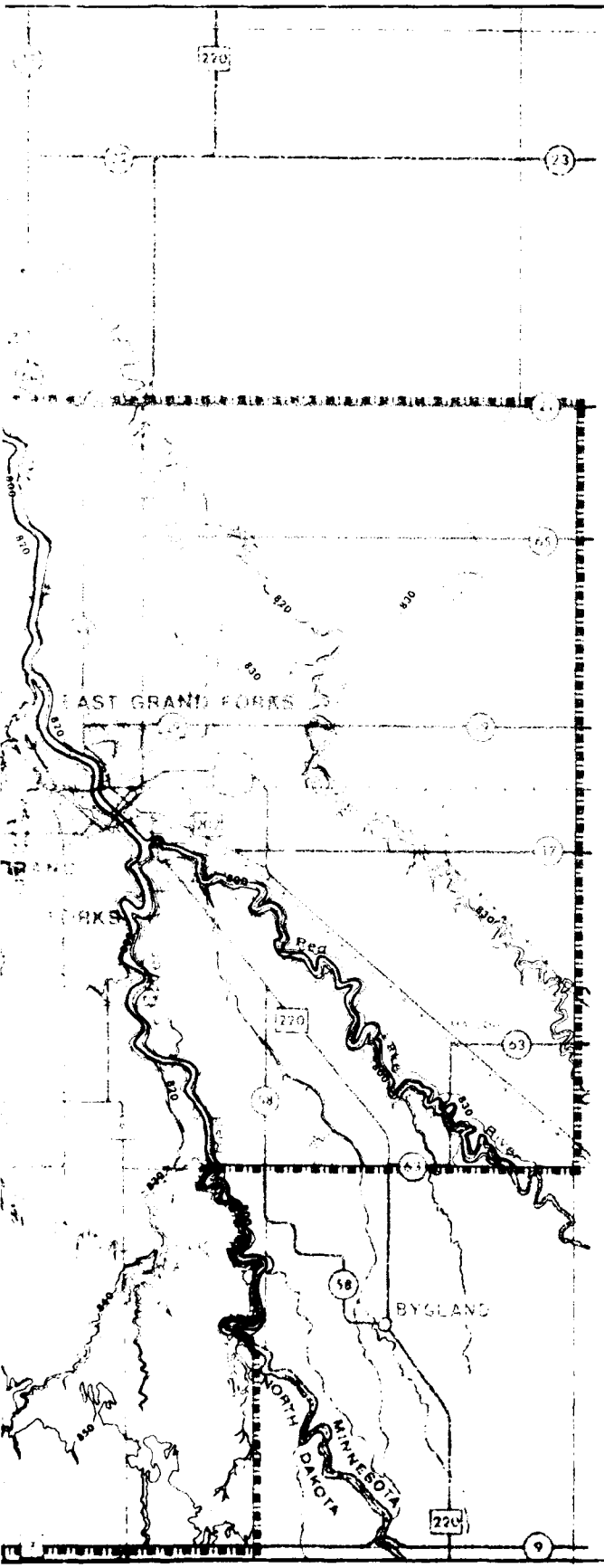

Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

CONTOUR INTERVAL EQUALS 10 FEET

SOURCE: U.S. GEOLOGICAL SURVEY

PLATE 2

SOILS

The soils of the Grand Forks-East Grand Forks study area represent the most valuable natural resource of the area. The most notable characteristic of area soils is the high inherent fertility of most soils within the Red River Valley.

The study area soils are derived almost entirely from glacial till and sediment from glacial Lake Agassiz. Most common in the Grand Forks and adjacent Grand Forks County study area are the medium and moderately fine-textured lake sediments. Soils in the beach areas west of Emerado, North Dakota, are loams and sandy loams underlain by gravel and coarse sand at depths of less than 2 feet. Along the western edge of the lake plain, water-worked till overlies undisturbed glacial till. Elk River delta, created by a glacial stream during the glaciation period, overlies part of the westernmost study area and generally consists of fine sandy loam to loam.

Soils on the Minnesota side of the Red River of the North are similar to those to the western side and generally consist of fine-textured prairie soils or deep black soil formed on glacial lake clay and silt which is very rich. East of the lake plain and outside the study area is a belt of fine sandy soils. Along the east edge of this belt, and at times intermixed, are the sand and gravel beach ridges.

Principal soil associations (see Plate 2) include the Hegne-Fargo, Bearden-Glyndon, Bearden-Saline, Glyndon-Bearden, and Cashel-Fairdale-Zell. The Cashell-Fairdale-Zell association, comprised of silty clays and sand, is of alluvial origin and is generally restricted to the stream corridors. Floodplain forest and open marsh areas are the typical vegetation found on these areas. The Hegne-Fargo soils, found principally on the Minnesota side of the river, are nearly level in a pattern of low interconnecting ridges and intervening low areas to pond surface run-off. Both soils of this group are fine-textured and somewhat poorly drained. The Fargo soils are found in the low areas, with the Hegne soils on the intervening ridges. Other soil characteristics for this and other study area soil associations are given in Table 2.

TABLE 2

STUDY AREA SOILS AND RELATED CHARACTERISTICS

Soil Association	Texture	Drainage	Typical Slopes	Water Holdi Capacity
Bearden-Glyndon	Moderately fine (Bearden) to medium (Glyndon) texture; Black layer overlying a layer of lime accumulation	Somewhat poorly drained	From nearly level (Bearden) to more than 2 percent (Glyndon)	High, moderate pe (Glyndon), seasona table
Fargo-Hegne	Fine-textured	Somewhat poorly drained to poorly drained (Hegne soils)	From nearly level to generally less than 2 percent	High, frequent high table in spring (He slow permeability (series)
Cashell-Fairdale-Zell	Loam to silty clay	Moderately well drained	Steep river bank slopes, flat bottomlands	
Glyndon-Bearden (Moderately saline)	See Bearden-Glyndon	See Bearden-Glyndon	See Bearden-Glyndon	High water table
Strongly Saline Soils		See Bearden-Glyndon		High water table
Buse-Zell-Fairdale	Loamy to clay loam	Generally rapid runoff	6 to 30 percent	Low due to rapid s runoff
Selz-Ops-Antler	Calcareous loam to silty clay loam, stone accumulations	Moderate to rapid runoff	Nearly level to steep slopes	Fair, poor on steep
Ulen-Embden-Hecla	Moderately coarse textured outwash and glacial lake deposits; Hecla - coarse grained	Moderately well to somewhat poorly drained	Range from level to very hilly areas	Good to fair water capacity

The Bearden-Saline soils also occur on the nearly level lake plain, with a pattern of intersecting and interconnecting rises or ridges that form polygonal patterns. These soils are moderately fine-textured and somewhat poorly drained, and show a black surface layer underlain by a layer of lime accumulation. The Bearden soils are found on the ridges and higher areas. Both soils are moderately to strongly saline. These soils are used for cropland but are affected by spring wetness.

The Glyndon-Vallers soils group, along the western edge of the lake plain, consists of a top layer of medium-textured lake sediments overlying glacial till at depths of 1 to 5 feet. These soils occur mostly on the level areas, with cropland being the principal use.

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TABLE 2

ILS AND RELATED CHARACTERISTICS

pes	Water Holding Capacity	Presettlement Vegetation	Principal Use(s)	Limitations on Use
eaded) to (Glyndon)	High, moderate permeability (Glyndon), seasonal water table	Tall grass prairie	Cropland; hay and pasture on poorly drained areas	Early spring wetness and seasonal water table; surface drainage required
enerally	High, frequent high water table in spring (Hegne soils), slow permeability (Fargo series)	Prairie grasses, forests along streambanks	Cropland; small grains	Poor surface drainage; early spring wetness limits range of moisture content at which tillage can be accomplished
es, flat		Floodplain forest, oak grasses on higher elevations	Cropland on higher areas, recreational and wildlife management uses along floodplain areas	Periodic flooding of low areas
	High water table	Prairie grasses	Cropland, small grains, sugar beets and potatoes	Sufficient salt accumulations may affect plant growth
	High water table	Prairie grasses	Cropland, pasture	Salt accumulations can stunt plant growth
	Low due to rapid surface runoff	Prairie grasses	Pasture	Steep slopes, high susceptibility to erosion when cultivated or overgrazed
slopes	Fair, poor on steep slopes	Prairie grasses and upland forest	Pasture, sand and gravel mining	Relatively low fertility, susceptibility to water induced erosion
very hilly	Good to fair water retention capacity	Prairie grasses, limited forest cover	Cropland, pasture on hilly areas	High susceptibility to wind erosion and early seasonal wetness

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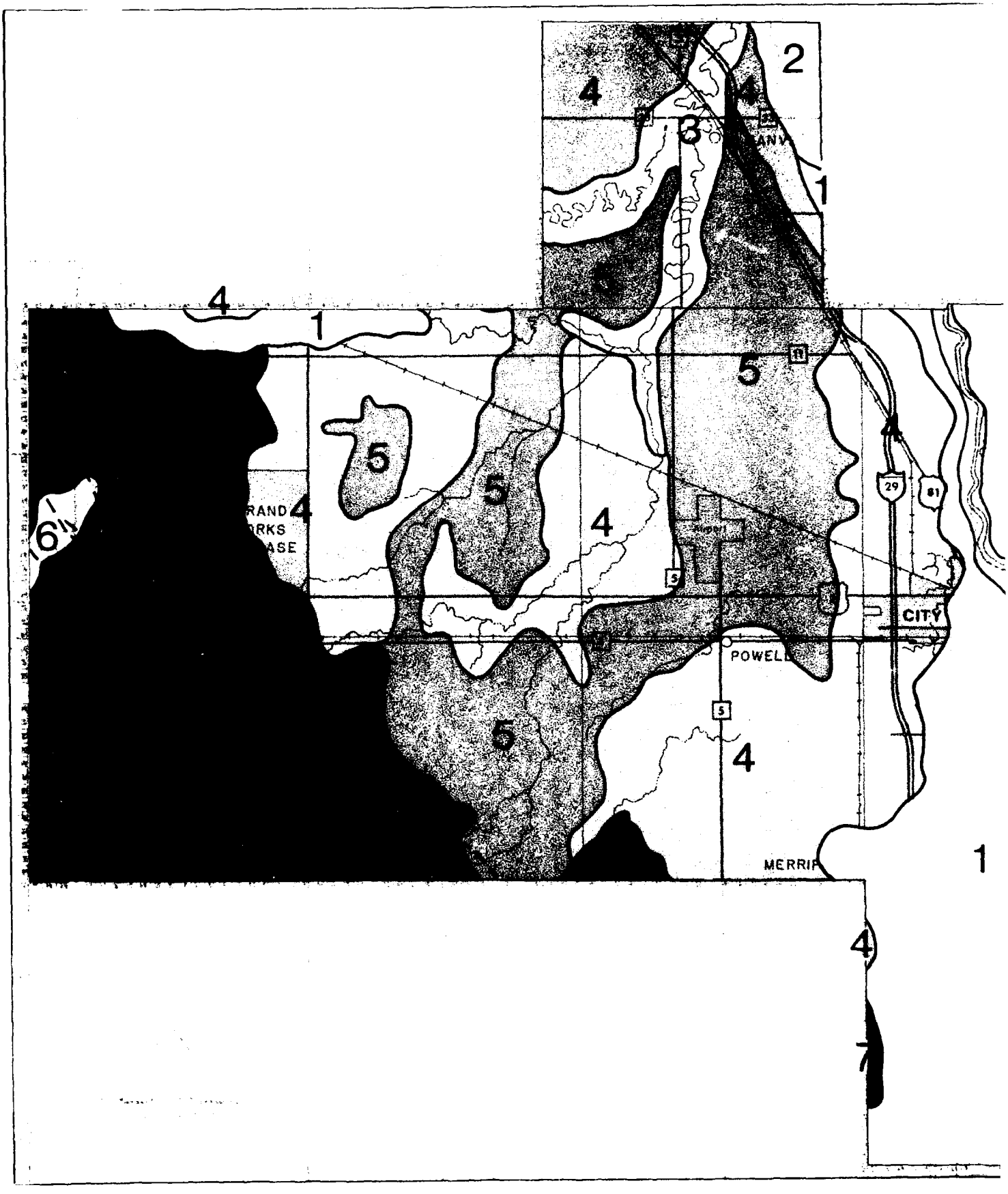
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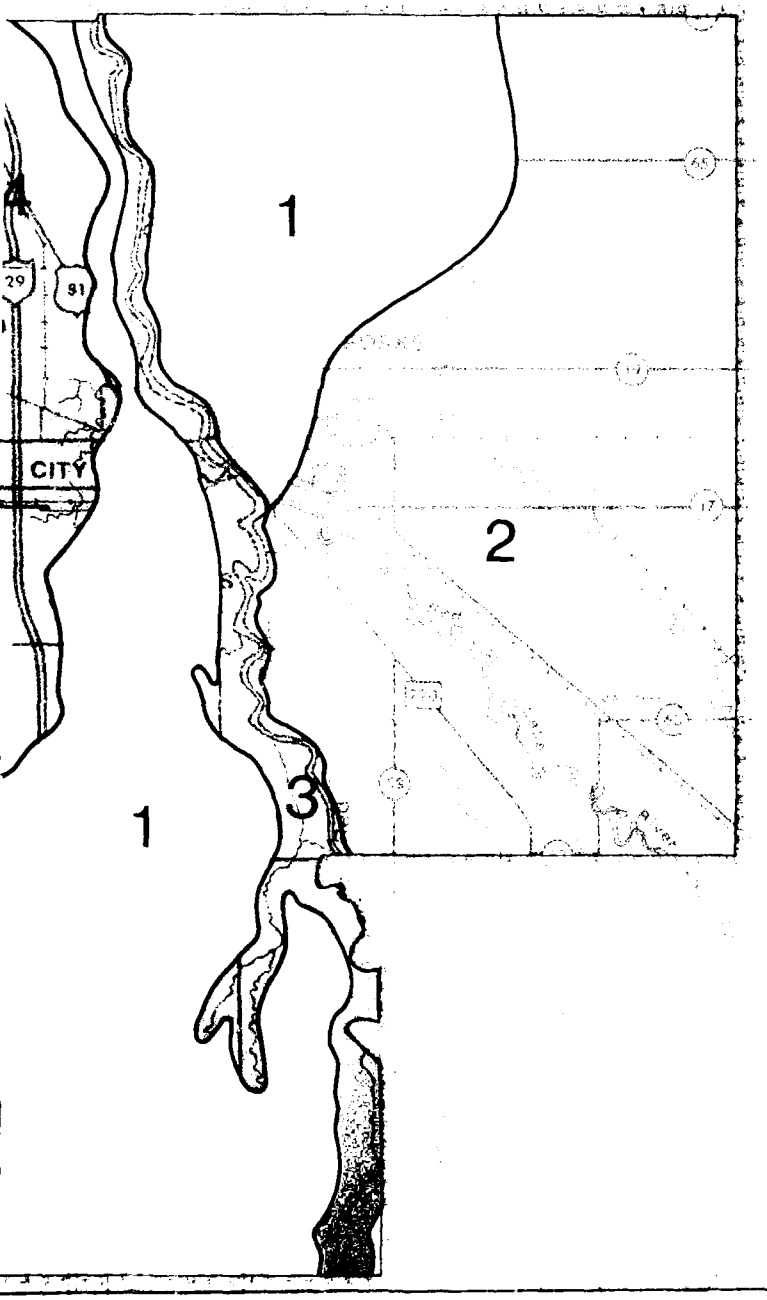
Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



SOIL ASSOCIATIONS

1	BEARDEN–GLYNDON ASSOCIATION
2	FARGO–HEGNE ASSOCIATION
3	CASHEL–FAIRDALE–ZELL ASSOC.
4	GLYNDON–BEARDEN ASSOCIATION (MODERATELY SALINE)
5	STRONGLY SALINE SOILS
6	BUSE–ZELL–FAIRDALE ASSOC.
	SELZ–OPS–ANTLER ASSOCIATION
	ULEN–EMBDEN–HECLA ASSOCIATION
- - -	GLACIAL LAKE BEACHES WITH DEEP SANDY THIN GRAVELLY SOILS.

SOURCE: REFERENCES 9,15,18.

PLATE 3

WATER RESOURCES

Surface Waters

Surface waters within the study area are comprised of the two major rivers, smaller streams, a network of drainage ditches, one man-made lake and several sewage lagoons. Of these surface waters, the Red River of the North and the Red Lake River are respectively the first and second most significant to the area. The two major communities within the region are located at the confluence of these rivers, as their names clearly imply. Lesser but locally significant streams include the Turtle River, which joins the Red River near Manvel; English Coulee, which joins the Red River just north of Grand Forks; Kellys Slough and Salt Water Coulee, which are tributaries of the Turtle River; and the Grand Marais River, which crosses the eastern part of the study area and exits into the Red River downstream of East Grand Forks.

Red River of the North at Grand Forks - East Grand Forks

No natural lakes exist in the study area. The most significant open water body is the 180-acre lake created by a riprap dam at the Kellys Slough National Wildlife Refuge. Other open water bodies include the sewage treatment lagoons operated by the communities, U.S. Air Force Base and American Crystal Sugar Company in East Grand Forks. These lagoons serve as a food source and resting area for wildlife. Plate 4 shows the location and extent of the major rivers, smaller streams and other surface waters in the study area.

As shown on the Water Resources Plate, stream meanders (loops) are common on all study area streams. These meanders are due to the flat slopes of the streams as they are situated on flat valley land created by former glacial Lake Agassiz. About 2 miles downstream of Grand Forks, the slope of the Red River of the North is only about 0.4 foot per mile. At Grand Forks, the Red River is about 200 feet wide and 8 to 10 feet deep during normal summer flows (Figure 7).

Kelly's Slough

The drainage area of the Red River of the North at the U.S. Geological Survey stream gage, located about 2 miles downstream of Grand Forks, is 30,100 square miles, including the 3,800-square mile Devils Lake subbasin. Included in the Red River drainage area is the Red Lake River subbasin which drains about 5,700 square miles in Minnesota. The Turtle River subbasin drains about 114 square miles of mostly agricultural land in east-central Grand Forks County.

The average flow of the Red River of the North at Grand Forks is approximately 2,500 cfs (cubic feet per second). Based on the 93-year record at the U.S. Geological Survey gaging station, the average, maximum and minimum river flows have been about 2,500, 80,000 and 2.4 cfs, respectively. Mean annual flow of the Red Lake River at East Grand Forks is about 2,000 cfs, with recorded minimum and maximum flows of 0 cfs (July 1960) and 28,400 cfs (April 1969), respectively.

Thus, of average Red River of the North flows at Grand Forks, approximately 45 percent is contributed by the Red Lake River. Average Turtle River flows over a 21-year period of record were approximately 48 cfs, with recorded minimum and maximum flows of 0 and 28,000 cfs (1950), respectively.

Frequent and coincidental flooding along the Red Lake River, the Red River of the North and English Coulee is a major problem in the urbanized study area. Floodplain areas outside the Grand Forks-East Grand Forks area are subject to general agricultural flooding but this is not considered a major problem in the study area. Flooding in the urbanized area frequently causes damages to residential, commerical and public park and recreation area property. The most frequently flooded area in Grand Forks is a residential area near Central Park. A total of 2,893 residential, commercial and public buildings are subject to direct flooding from the 100-year flood (1 percent chance of occurring in any given year) at Grand Forks. The downtown area of East Grand Forks is most frequently affected by indirect flooding (sewer backup and basement flooding); almost a thousand structures are subject to direct flooding from the 100-year flood level.

Surface water quality of the Red River of the North and Red Lake River is directly affected by riverbank and other erosion, agricultural practices and disposal of wastewater effluents from upstream communities. Localized water quality problems are caused in part by municipal and industrial waste discharges. Feedlot runoff and fertilizers are also contributing factors. Non-point sources contribute a majority of the nutrient loading in these rivers, and a substantial portion of other pollutants. Principal industrial contributors include the sugar beet and potato plants at Crookston and East Grand Forks, Minnesota, and the Fargo-Moorhead area. Total dissolved solids for both the Red River of the North and the Red Lake River are generally less than 500 mg/l (milligrams per liter). Hardness in the Red River of the North generally exceeds 180 mg/l but is generally less than 180 mg/l in the Red Lake River. At low Red Lake River flows, a critical buildup of wastes occurs, with total dissolved solids and hardness greatly exceeding the above values. Purification and treatment of waters from both rivers are required for municipal, industrial and rural domestic uses.

The stream classification and establishment of water quality and purity standards for the Red Lake River from Crookston to the mouth (East Grand Forks) were adopted by the Minnesota Pollution Control Agency in July 1966, and are outlined in Minnesota Regulation WPC 10, Chapters 115 and 116, State Statutes. Under these regulations, the Red Lake River from the mouth to Crookston has been classified as a Class 1C, 2B, 3B stream. Standards of surface water quality for the Red River of the North and other streams in North Dakota are documented in Regulation 61-28-05.2, I through VIII. Under this regulation, the Red River of the North and Turtle River have been classified as Class I and II rivers, respectively. A comparison of State water quality standards for selected substances as established by both States is given in Table 3. Also shown are State standards for the same substances as established for the Red Lake River.

TABLE 3

WATER QUALITY STANDARDS - SELECTED SUBSTANCES
(MINNESOTA AND NORTH DAKOTA)

Substance	Red River of the North		Red Lake River
	Minnesota	North Dakota	Minnesota
Turbidity (FTU or JTU)	25 FTU	10 JTU	25
Dissolved Exygen (mg/l)	5	5	5
Ammonia (mg/l)	1.5	.02	1.0
Hardness (mg/l)	250	---	200
Fecal Coliforms (MPN/100 ml.)	250	200	200

Source: Minnesota and North Dakota Water Quality Standards, References 26 and 27

Groundwater

Groundwater is a significant resource of the Grand Forks-East Grand Forks region as much of the rural population in the area is dependent on groundwater for domestic and livestock needs. However, much of this water is highly mineralized and of moderate to high salinity. Two types of aquifers supply groundwater to the study region. These are glacial drift aquifers which include the Elk Valley, Inkster, Thompson, Emerado, and Grand Forks aquifers and aquifers of the preglacial rock (Ordovician System), in which the Dakota Aquifer is located. For locations of these aquifers and their average yields, see Figure 5.

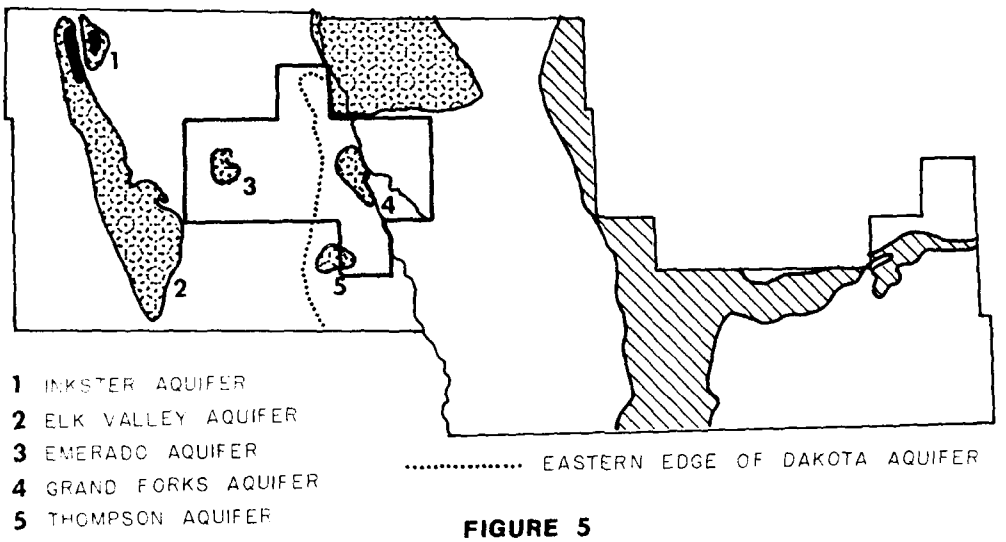


FIGURE 5

MAJOR GLACIAL DRIFT AQUIFERS AND YIELDS OF WELLS IN GRAND FORKS AND POLK COUNTIES

SOURCE: REFERENCE NO. 3 & 18

Of these aquifers, the Dakota is by far the largest, in terms of both amount of water contained and areal extent. It has been described as extending as far south as New Mexico and as far west as Montana. Water from the Dakota Aquifer is very saline and generally unsatisfactory for domestic uses without treatment. It is generally highly toxic to vegetation and too mineralized for livestock purposes. The Elk Valley aquifer served as one of the earliest sources of municipal water supplies and is the current source of supply for the Grand Forks-Traill Rural Water System. Five wells drilled to 60-to-100 foot depths in this 30-to-35 foot thick aquifer provide a combined maximum sustained yield of 700 gpm (gallons per minute) to the system.

Groundwater quality varies substantially over the study area, but is generally characterized by water of moderate to extreme hardness. Waters of the Dakota sandstone aquifer underlying the Grand Forks area are very saline, have an average dissolved solids (D.S.) content of 4,400 ppm (parts per million) and excessive amounts of chloride, iron and sulfates, and are highly toxic to most domestic plants. Waters of the Grand Forks aquifer underlying the city at lesser depths are very hard, with a dissolved solids content in excess of 7,500 ppm, and would be highly injurious to plants and soils. Groundwater in the localized Thompson aquifer is also very hard (D.S. = 4,500 +ppm), highly mineralized and very saline. Water quality parameters obtained from readings of selected wells in the principal Grand Forks County aquifers are given in Table 4.

TABLE 4

CHEMICAL ANALYSES OF SELECTED WATE
GRAND FORKS COUNTY, NORTH DA

(Analytical Results in Parts Per Million Except

Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Sum	Dissolved Solids Residue on Evaporation at 180 Degrees F	Hardness as $CaCO_3$ Calcium Magnesium	Hardness as $CaCO_3$ Non-carbonate	Aquifer	Depth	Source*	D Co
984	1,960	.8	1.9	2	4,720	4,840	1,280	1,120	Thompson	275	Qd	9
285	206	.2	547	0.00	1,670	1,750	870	619	Dakota	400	Kd(?)	10
1,530	1,170	2.8	2.0	3.1	4,320	4,230	900	694	Dakota	108	Kd	8
1,450	1,990	2.0	.4	3.5	5,560	---	1,090	860	Dakota	140(?)	Kd	9
733	368	.3	5.4	.97	1,850	1,890	835	619	Emerado	90	Qd	9
1,350	1,930	.9	50	2.8	5,260	---	1,280	1,110	Grand Forks	210	Qd	9
1,010	1,580	.5	1.9	2.0	4,260	4,310	1,070	855	Kelly Slough	75	Qd	8
149	15	.3	.2	.08	554	645	446	129	Elk Valley	14	Qev	7

* Kd - Dakota Group of Cretaceou
Qd - Glacial drift of Quaternary
Qev - Elk Valley delta deposits of

As evidenced by their use as area water supplies, the beach ridge aquifers are substantially lower in hardness and mineral content than the lake plain aquifers. Groundwater in the Elk Valley aquifer, hard by national standards, is soft in comparison to other area aquifers, with a total dissolved solids content averaging 630 ppm. It is of medium to high salinity and low sodium content. The Inkster aquifer, of medium salinity, is of excellent quality except for hardness (D.S. of 350 ppm). Groundwater on the Minnesota side is highly mineralized and very hard, with hardness values of 600 to 1,000 mg/l at East Grand Forks.

TABLE 4

ES OF SELECTED WATER SAMPLES
S COUNTY, NORTH DAKOTA

Parts Per Million Except as Indicated)

Depth	Source*	Date of Collection	Temperature (degrees F)	Silica (SiO_2)	Total Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)
275	Qd	9-21-66	50	24	.52	328	112	1,190	24	191	0
400	Kd(?)	10-12-66	50	20	.46	152	119	158	25	307	0
108	Kd	8-12-65	47	19	1.10	226	82	1,120	34	252	0
140(?)	Kd	9- 7-65	48	17	1.70	270	101	1,550	40	278	0
90	Qd	9-13-66	54	27	.22	205	79	289	17	264	0
210	Qd	9-10-65	--	12	.00	306	126	1,360	27	204	0
75	Qd	8-18-66	48	26	.92	272	95	1,100	28	263	0
14	Qev	7-15-65	48	14	.04	119	36	23	6.4	387	0

akota Group of Cretaceous age
lacial drift of Quaternary age
lk Valley delta deposits of Quaternary age

Source: Bulletin 53, Part II, North Dakota Geological Survey

Remarks: Analyses by North Dakota State Laboratory Department

Water Management Activities

Water management activities in the study area are accomplished by several Federal, State and local agencies, and in a few cases by groups representing several of the agencies. On a basin-wide basis, the Souris-Red-Rainy Regional Office of the Upper Mississippi River Basin Commission, located at Fargo, North Dakota, is charged with the orderly planning and development of the basin water and related land resources. Working with this office at the Federal level on a continuing basis are the U.S. Geological Survey, U.S. Army Corps of Engineers and U.S. Soil Conservation Service. Principal state agencies involved in area water management include the North Dakota State Water Commission and the Minnesota Department of Natural Resources. On the regional level, interested agencies include the Red River Development Council in North Dakota, the Northwest Regional Development Commission in Minnesota, and the Red River Water Management Board. Representing county-level activities are the West Polk County Soil and Water Conservation District, the Red Lake Watershed District and the Grand Forks County Water Management Board.

Numerous studies and projects for flood control in the study area have been completed. Completed studies and investigations include the Souris-Red-Rainy River Comprehensive Framework Plan (Appendices D, G and H) by the regional Commission office; survey studies completed by the Corps of Engineers at Grand Forks-East Grand Forks and along the Red Lake River; various basic water resource investigations by the U.S. Geological Survey; Type 15 and 19 flood insurance studies at Grand Forks by the Soil Conservation Service in 1972 and 1973, respectively; and a Grand Forks floodplain information report completed by the Corps of Engineers in 1971.

Completed major flood control projects affecting the study area include reservoir or lake storage on the Sheyenne River (junction with the Red River at Fargo) and upper Red Lake River. Other completed projects include stream channelization projects in the Red Lake River watershed, local flood barriers at Grand Forks, extensive drainage and land reclamation projects in Grand Forks and Polk Counties, permanent federally-constructed levees at Lincoln Park in Grand Forks and emergency levee works left in place after recent major floods at East Grand Forks (see Figure 6).

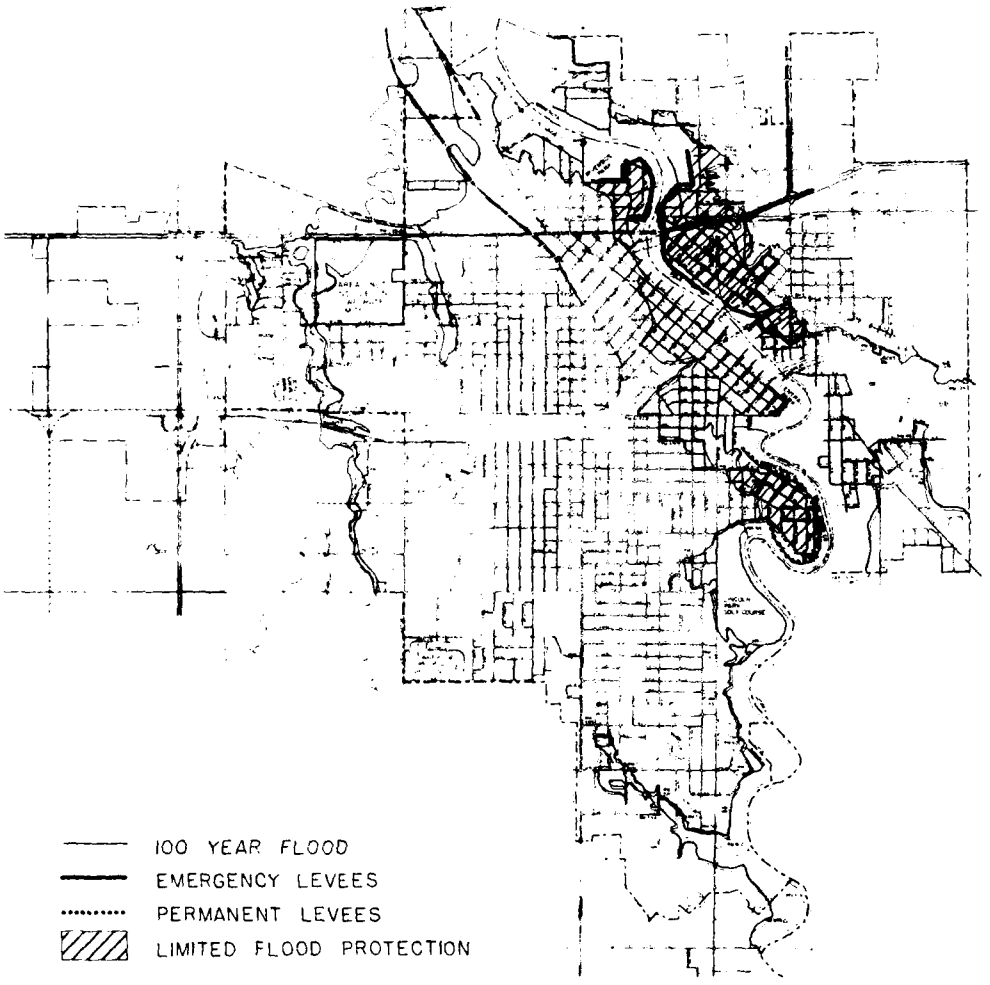


FIGURE 6

EXISTING FLOOD CONTROL FACILITIES
IN THE GRAND FORKS - EAST GRAND FORKS URBAN AREA

SOURCE: REFERENCE NO. 32

Grand Forks has adopted zoning regulations for floodplain areas. East Grand Forks has floodway zoning regulations and is developing floodplain regulations. Proposed zoning regulations incorporating floodplain zoning provisions for Grand Forks County are presently under review.

Current activities for flood damage reduction and drainage in the study area include the authorized Corps of Engineers Red River of the North Basin Study; the continuing Red Lake River study; and the flood control improvements by the Soil Conservation Service at the confluence of Belmont Coulee and the Red River of the North at Grand Forks. A recent proposal to realign a portion of English Coulee in the far western and northwestern portion of Grand Forks is pending. An authorized Corps of Engineers flood control project at East Grand Forks would provide for levees, floodwalls and related drainage works to provide protection against the 50-year flood level with 2 feet of freeboard (distance from design floodwater level to top of levee).

Wastewater Treatment

Grand Forks disposes of its sanitary and industrial wastes in a 640-acre lagoon system located approximately 4.3 miles northwest of the city, as shown on the Sewage and Water Supply Systems Plate (Plate 5). The system, constructed in 1970 under an Environmental Protection Agency research and development grant to service a population equivalent to 150,000 persons, consists of an 8-acre pretreatment facility and 2 primary and 2 secondary cells (lagoon divisions). Sewage is delivered through a 30-inch force main to the pretreatment facility where it undergoes aerobic decomposition before proceeding to the main lagoon area for retention until Red River of the North water quality standards are met. The lagoon system is designed for a 5.4 mgd (million gallons per day) sewage flow and a 180-day detention or storage period. Recent (1976) average observed flows have reached 6.0 mgd. The sewage is stored over the winter and released to the Red River of the North during the spring and summer. Present expansion plans are to add 320 acres of lagoon and expand the collection system to new areas as they are annexed into the City.

The U.S. Environmental Protection Agency has provided a Section 201 (see Public Law 92-500, Water Pollution Control Act Amendments) Facilities Grant to Grand Forks for a study of its sewage treatment system. As a result of this study, a Section 201 Facilities Plan has been developed, but is awaiting industry cost sharing approval.

Wastewater from the Grand Forks Air Force Base is disposed of in a 160-acre lagoon located about 2 miles east of the base (see Plate 5). The system can handle an estimated maximum 1.2 mgd sewage flow. The actual estimated peak flow rate, based on a recent 9-month period, was between 0.7 and 0.9 mgd. Recorded effluent quality values have been well below permit requirements, as indicated by maximum B.O.D. (5-day) and suspended solids values of 14.2 mg/l (std. weekly = 45 mg/l max.) and 20.0 mg/l (std. weekly = 45 mg/l max.), respectively. Effluents from the lagoon are released into the Turtle River via a small tributary during the spring and summer and eventually flow into the Red River of the North.

East Grand Forks similarly disposes of its sanitary wastes into a lagoon. The disposal system includes a 2-cell, 336-acre lagoon located approximately 1-1/2 miles north of the city, as shown on Plate 5. It serves both residential and industrial users, and, in 1971, had 2,400 paying accounts, of which 270 were commercial users. The system, fed by a 30-inch force main, is designed for a 1.4 mgd flow rate and 180-day storage time. Effluent from the lagoon is released into the Red River of the North at a point north of the city during the spring and fall. The estimated 1976 flow was 1.0 mgd. The city lagoon system meets all Federal and State standards. No differences exist between the present State standards (reference Water Pollution Control Standards WPC 1 through WPC 34, Chapters 115 and 116, State Statutes) and the 1977 or 1983 Federal requirements (reference 1972 Water Pollution Control Act Amendments, Public Law 92-500).

The City of Thompson is served by a 2-cell lagoon system totaling about 4.3 acres and located about one-half mile southeast of the city (see Plate 5). Effluent from the lagoons is discharged into Elm Coulee, which drains into the Red River of the North east of Thompson. The system was designed for a 27,000 gpd (gallons per day) flow and a 180-day storage time. No discharge was reported during the period of 1 January 1975 to 31 December 1976. However, the rapid increase in population in recent years has resulted in an estimated storage requirement of about 30 percent above the design capacity. The two cells (ponds) are presently not operating properly due to ground seepage and percolation. New and larger ponds have been proposed at a site south of the city limits. A Section 201 Facilities Plan for

the city has been approved by the North Dakota Department of Health and is currently under review by the U.S. Environmental Protection Agency.

Manvel is served by a 2-cell (pond) lagoon system totaling 11 acres and located one-half mile west of the city, as shown on Plate 5. The system, three to four years old, is designed to serve a population of 600 (1970 population of 265) and discharge into the Turtle River. However, no discharges have occurred to date.

Emerado discharges its sewage into a 5-acre lagoon system located east of the city. The system is designed for a flow of 25,000 gpd and a storage time of 6 months. Effluents from the lagoon are discharged into Salt Water Coulee, which eventually discharges into the Red River of the North downstream of Grand Forks via the Turtle River. No discharges werereported during the period of 1 January 1975 to 1 January 1977. A submitted interim compliance schedule to meet secondary treatment limitations is contingent upon future availability of of funds. Other rural wastewater needs, mostly individual farm sites, and small clusters of homes such as at Merrifield, Powell, and Mekinock are met by private septic systems.

Typical Sewage Lagoon

Water Supply

The greater part of Grand Forks is served (see Plate 5) by a municipally owned and operated water distribution system. The treatment plant has a capacity of 9.0 mgd and utilizes the Red River of the North and Red Lake River as raw water sources, with the Red Lake River being the best source. The treatment plant provides taste and odor control and reduction of hardness. It also uses chlorine, fluoride and other chemicals in the treatment process. The city system also supplies the water needs of the Grand Forks Air Base to a maximum of 2.5 mgd, in accordance with a present contract with the U.S. Government. Total average consumption increased from 4.5 mgd in 1968 to 7.1 mgd in 1972, with a maximum 1972 daily demand of 10.5 million gallons. To meet a projected maximum demand of 21.8 mgd by 1983, a new 7 million gallon ground storage reservoir and a 7 mgd pumping station were recommended in a 1973 study. The pumping system has recently been completed. Increasing industrial demands, principally from the potato processing industry and the Grand Forks Air Base, resulted in a 1974 recommendation for expansion of the water treatment plant capacity. A summary of 1972 municipal and industrial water demands in Grand Forks and East Grand Forks is given in Table 5.

In addition to the municipal distribution system, smaller portions of the city that have previously been served by the Grand Forks-Traill Rural Water System (see Plate 5) retain this service after annexation to the city. A number of residential users, primarily in the southeastern portion of the city, are served by individual cisterns periodically filled by commercial water haulers.

East Grand Forks water supplies are furnished by the municipal water and light authority. The system (Plate 5) draws raw water from the Red Lake River and consists of a 4 mgd pumping plant, a lime soda ash process treatment plant and a city-wide distribution system. Average demand is less than 2 mgd, with maximum demand exceeding 2 mgd. Present storage capacity is 1,600,000 gallons. Additional facilities under construction include a 500,000 gallon elevated reservoir and a 2 million gallon underground reservoir.

Thompson has been served by the Grand Forks-Traill Water Users Corporation since October 1972. Water for the system is obtained from wells in the vicinity of Inkster, North Dakota. Average consumption per user member (160 members on 19 August 1976) is approximately 6,000 gallons per month.

Emerado is served by its own municipal water system using a five-well source (4 wells operational at the present time) located 4 miles southwest of Arvilla in the Elk Valley aquifer. Arvilla and a few individual customers are also served by the system. The water supply is considered sufficient to meet projected growth.

Manvel is provided water by the Agassiz Rural Water System (see Plate 5 for service area). This system also draws its source from wells in the Elk Valley beach ridge deposits. The water is considered of excellent quality and of adequate volume to meet projected city growth.

Private f msteads and other consumers in the rural Grand Forks County area are served either by private wells or the two rural water systems. Rural residences in the Polk County study area are served by the Marshall-Polk Rural Water System or by private wells.

TABLE 5

WATER SUPPLY DEMAND
GRAND FORKS - EAST GRAND FORKS

Community	1972 Demand (mgd)
Grand Forks Area	
Grand Forks	4.50
Air Force Base	0.75
Thermal Power (2 plants)	18.54
Pillsbury	0.65
Frito-Lay	0.04
Rogers Bros. Potato Co.	0.10
Associated Potato Growers, Inc.	0.01
Western Potato	0.75
East Grand Forks	
East Grand Forks	0.55
American Crystal Sugar	1.0
King of Spud	0.4
Old Dutch Foods	0.06

Source: References 33 and 48

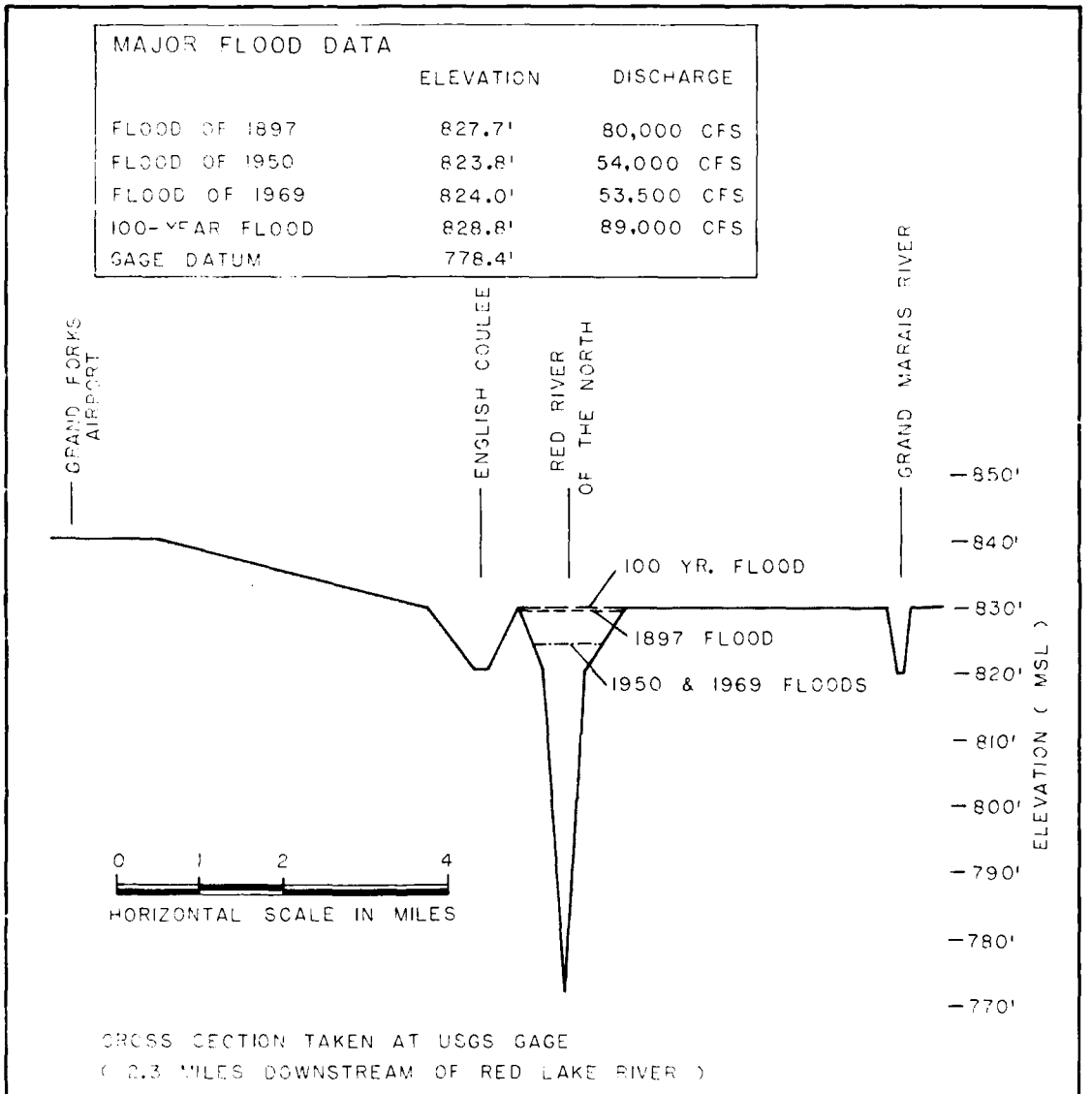


FIGURE 7

TYPICAL CROSS SECTION OF THE RED RIVER OF THE NORTH VALLEY

SOURCE: REFERENCE NO. 1 & 15.

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Upper Mississippi River Basin Commission - Regional Office, **Appendix D, Souris-Red-Rainy Basins Comprehensive Study Report,** 1972

Upper Mississippi River Basin Commission - Regional Office, **Appendix G, Souris-Red-Rainy Basins Comprehensive Study Report,** 1972

Upper Mississippi River Basin Commission - Regional Office, **Appendix H, Souris-Red-Rainy Basins Comprehensive Study Report,** 1972

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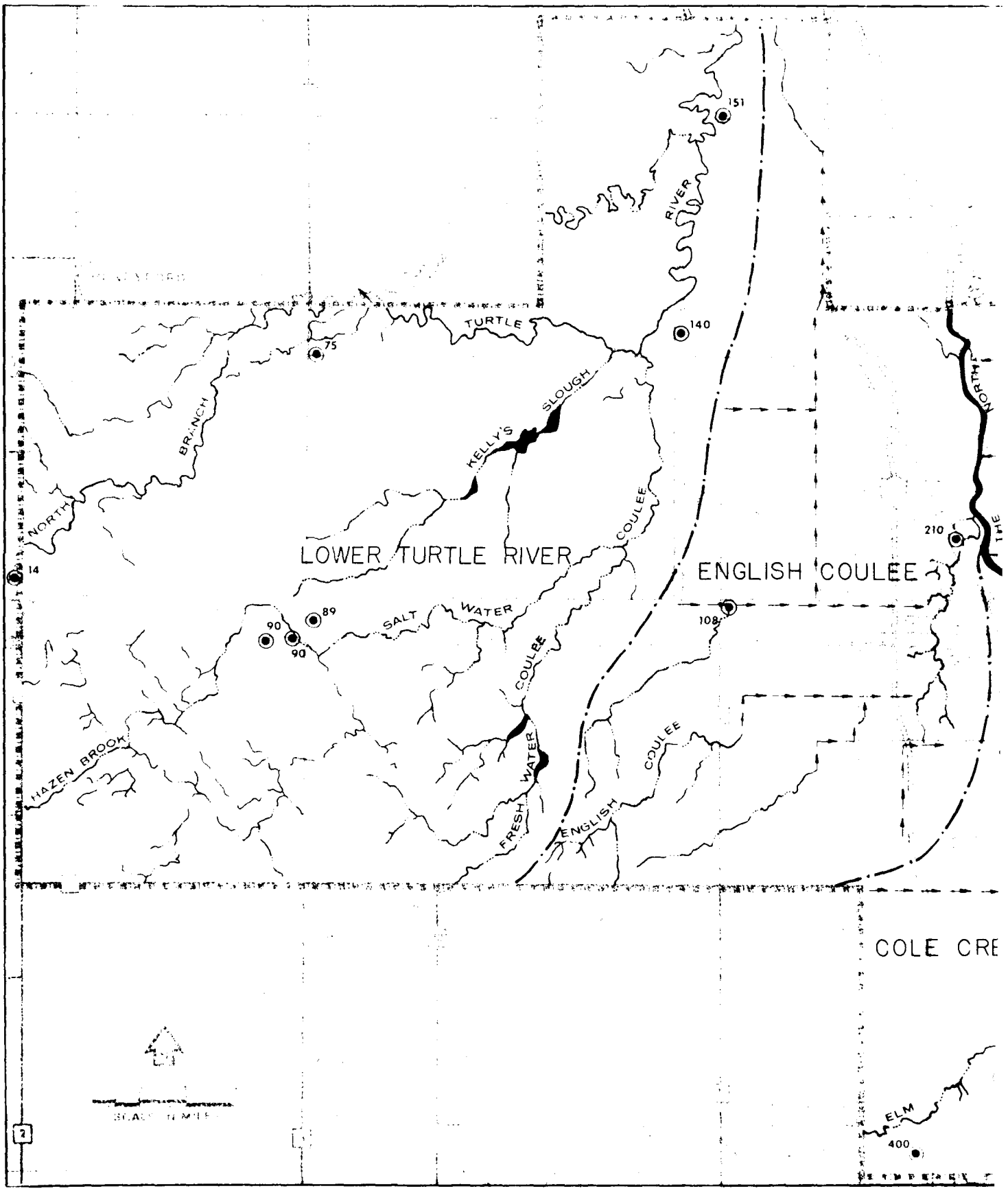
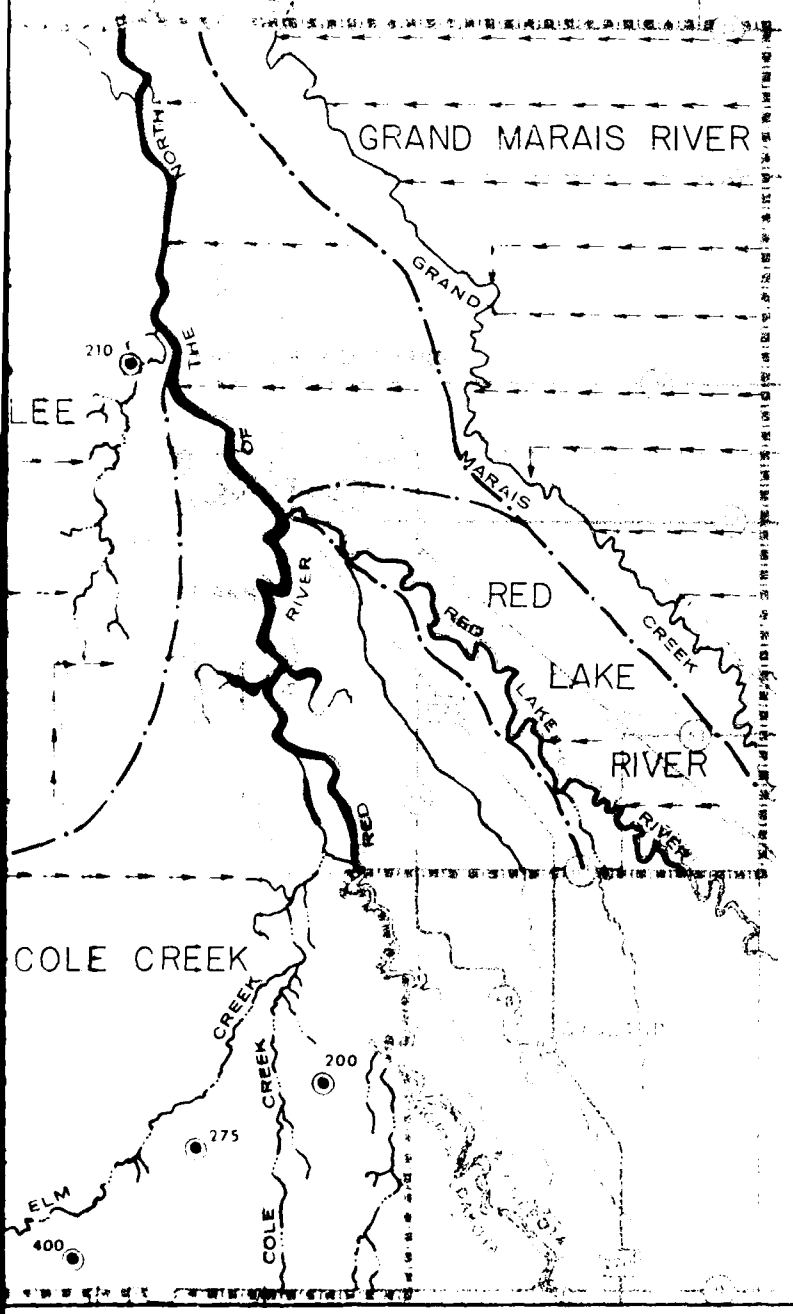

151
RIVER
TURTLE
140
75
SLOUGH
KELLY'S
BRANCH
NORTH
NORTH
THE
210
14
LOWER TURTLE RIVER
COULEE
ENGLISH COULEE
89
SALT WATER
90
90
108
COULEE
HAZEN BROOK
FRESH WATER
ENGLISH
COULEE
COLE CRE
ELM
400

Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



LAKES AND PONDS

MAJOR RIVER SYSTEMS

SECONDARY
OR INTERMITTENT STREAMS

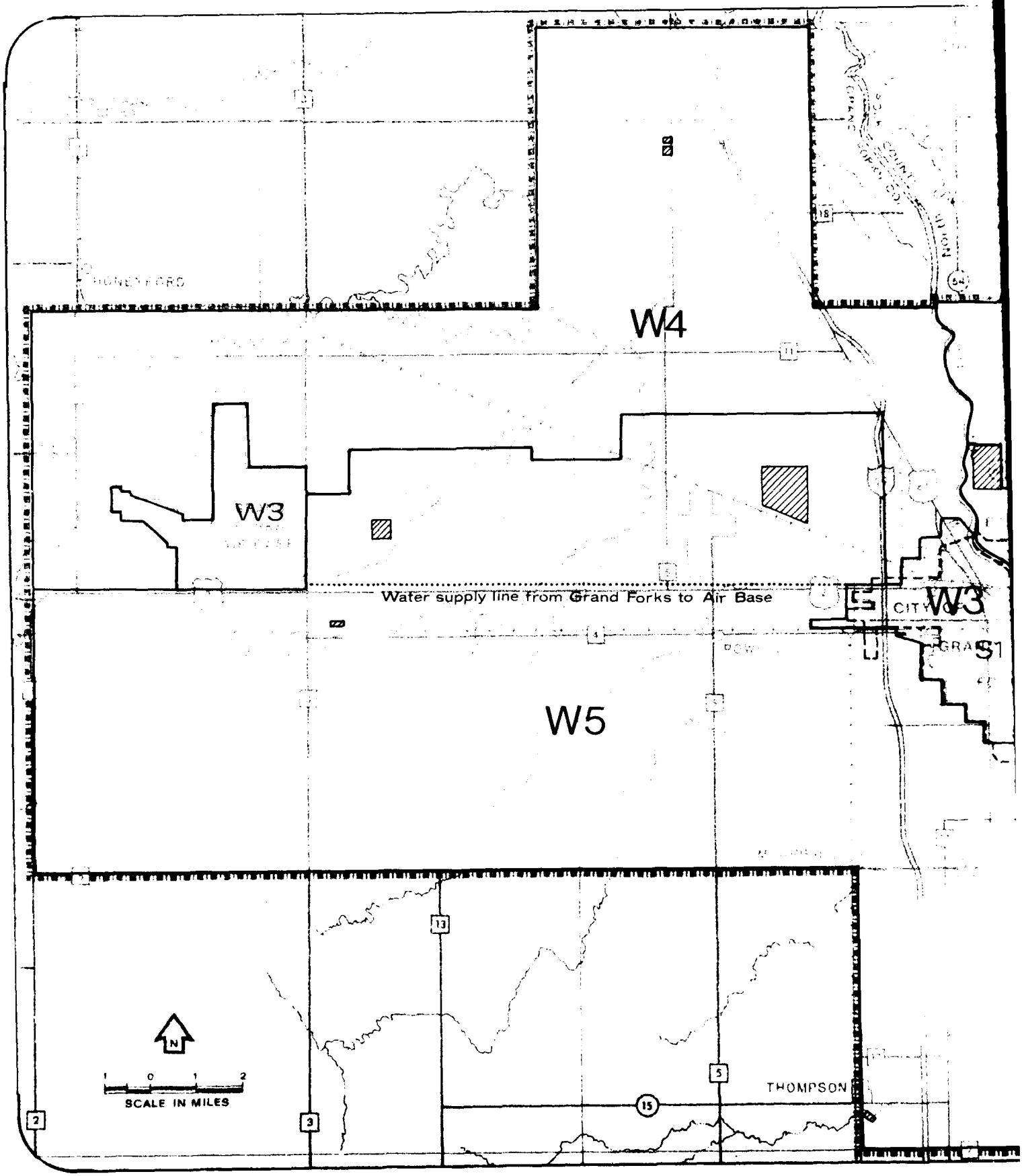
DRAINAGE DITCHES

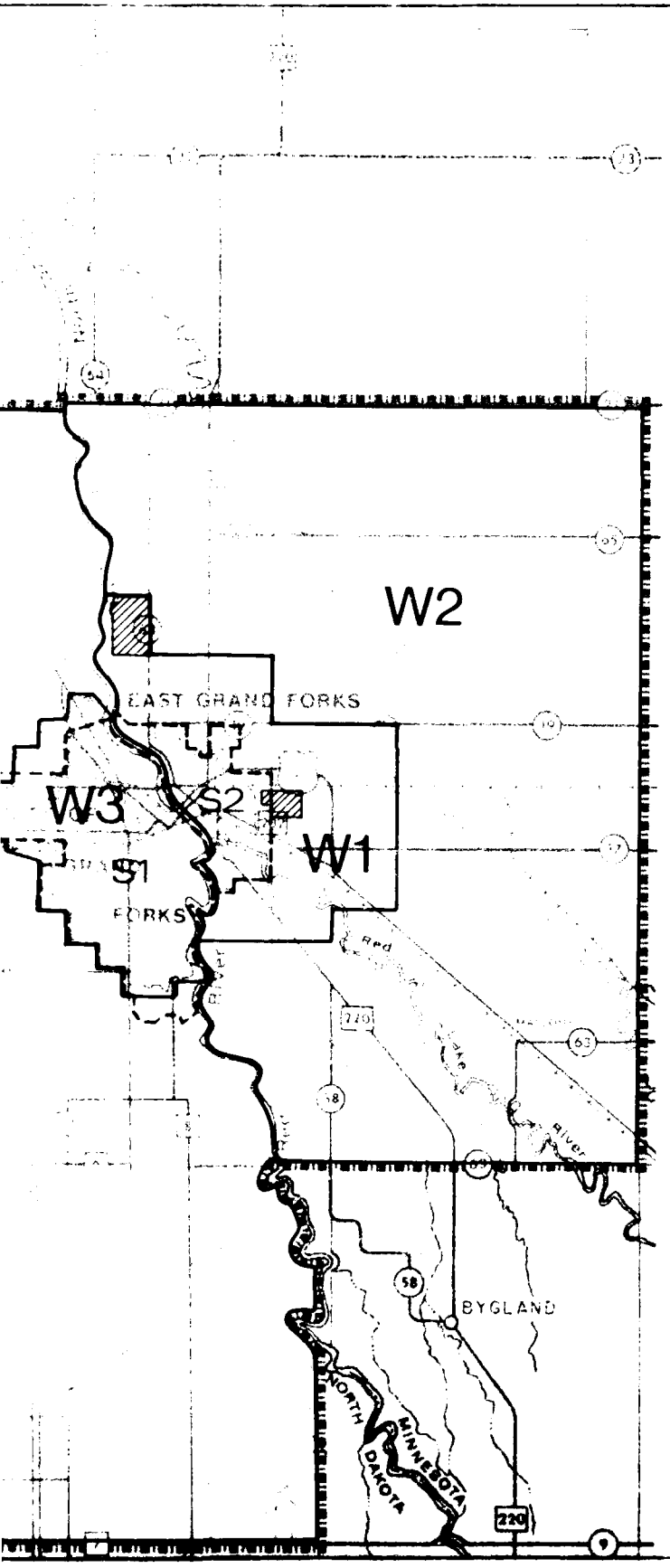
DRAINAGE AREAS

210 GROUNDWATER QUALITY WELL AND DEPTH IN FEET (SEE TABLE 4)

SOURCE: REFERENCES 14,15,18.

PLATE 4


W4
W3
W3
W5
Water supply line from Grand Forks to Air Base
THOMPSON
N
1 0 1 2
SCALE IN MILES



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

SEWAGE SERVICE AREAS

- S1 — CITY OF GRAND FORKS
- S2 — CITY OF EAST GRAND FORKS
- SEWAGE LAGOONS

WATER SUPPLY SERVICE AREAS

- W1 — CITY OF EAST GRAND FORKS
- W2 — MARSHALL AND POLK RURAL WATER SYSTEM
- W3 — CITY OF GRAND FORKS
- W4 — AGASSIZ WATER USERS INC.
- W5 — GRAND FORKS-TRAILL SYSTEM

SOURCE: REFERENCE 172 THRU 175

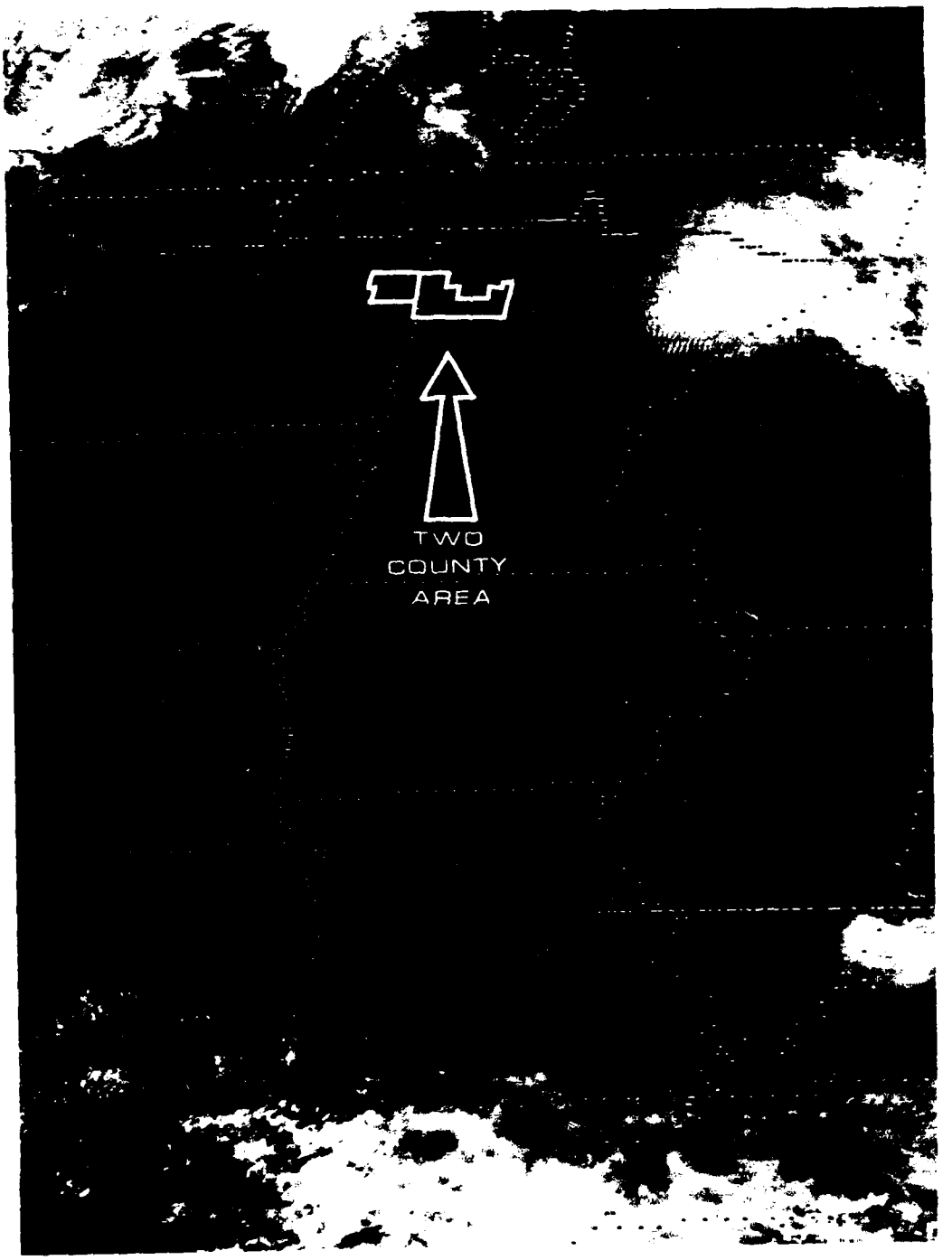
PLATE 5

CLIMATE

The Grand Forks-East Grand Forks area has a typical continental climate characterized by wide variations in temperature, light to moderate precipitation, plentiful sunshine and nearly continuous air movement. Weather patterns consisting of cold, dry air from polar regions and warm, moist air from tropical regions often move quickly into the area, resulting in the characteristic temperature variations. The climatic classification of the area as related to the midwestern region of the United States is shown on Figure 8. The locations and types of weather observation stations are shown on Figure 9. Weather records have been observed at Grand Forks (University of North Dakota) since January 1898, and data given below are from these observations.

In the winter, movement of polar air into the area often results in bitter cold temperatures. Temperatures drop to 0 degrees F (-18 degrees C) or below on an average of 60 days each year. The coldest month on record, February 1936, had an average temperature of -13 degrees F, 21 degrees below the normal temperature of 8 degrees F. Monthly maximum and minimum temperatures recorded at Grand Forks for the years 1898-1966 are shown in Tables 6 and 7, respectively. A summary of mean and extreme temperatures is given in Table 8. The average precipitation during January, February and March is 1.87 inches and the average yearly snowfall is 34.9 inches. Total monthly and total annual precipitation for the years of record 1898-1966 are given in Table 9. A summary of monthly and annual seasonal snowfall at Grand Forks for the years 1898-1966 is given in Table 10.

Spring is a time of rapid and large changes in temperature and precipitation. During April the most rapid warming occurs, with average monthly temperatures 18 degrees F higher than those of March. The average day of last frost is May 19, but freezing temperatures have been recorded as late as June. Average precipitation during April, May and June is 7.50 inches, more than four times that of the winter months.



Weather Satellite Photo

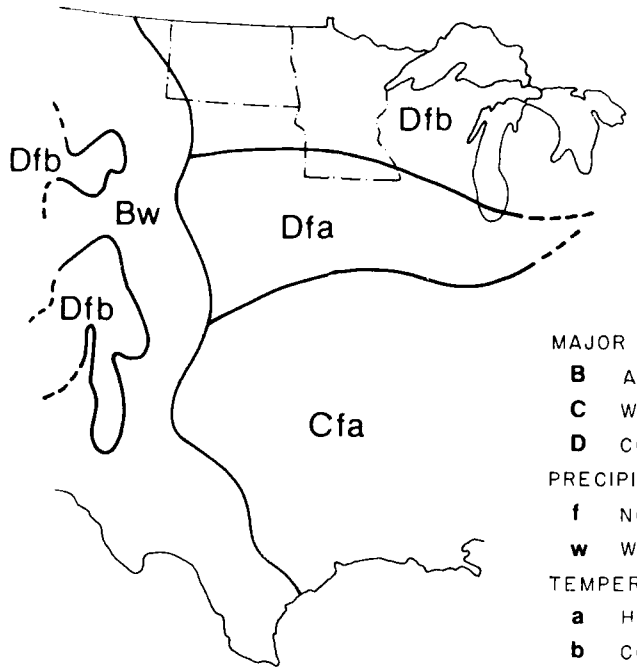


FIGURE 8

CLIMATE CLASSIFICATION OF THE MIDWESTERN UNITED STATES

SOURCE: NATIONAL WEATHER SERVICE

The summer months are characterized by nearly continuous bathing of weather patterns from the arid south. The average precipitation during the summer is 7.88 inches, slightly more than that of the spring months. The summers are warm but not hot, as maximum temperatures of 90 degrees F or more occur on an average of only 12 days a year.

The first frost of fall, which usually occurs in mid to late September, signals the end of the growing season and indicates that about 2 months remain until winter. The percent probability of freeze occurrence in the spring and fall in the area is given in Table 11. Average frost penetration at Grand Forks is 4.5 feet, with an extreme of about 7 feet. A large decrease in precipitation occurs during the transition from summer to fall; the average total precipitation for October, November and December is 2.77 inches, almost one-third that of the average total summer precipitation.

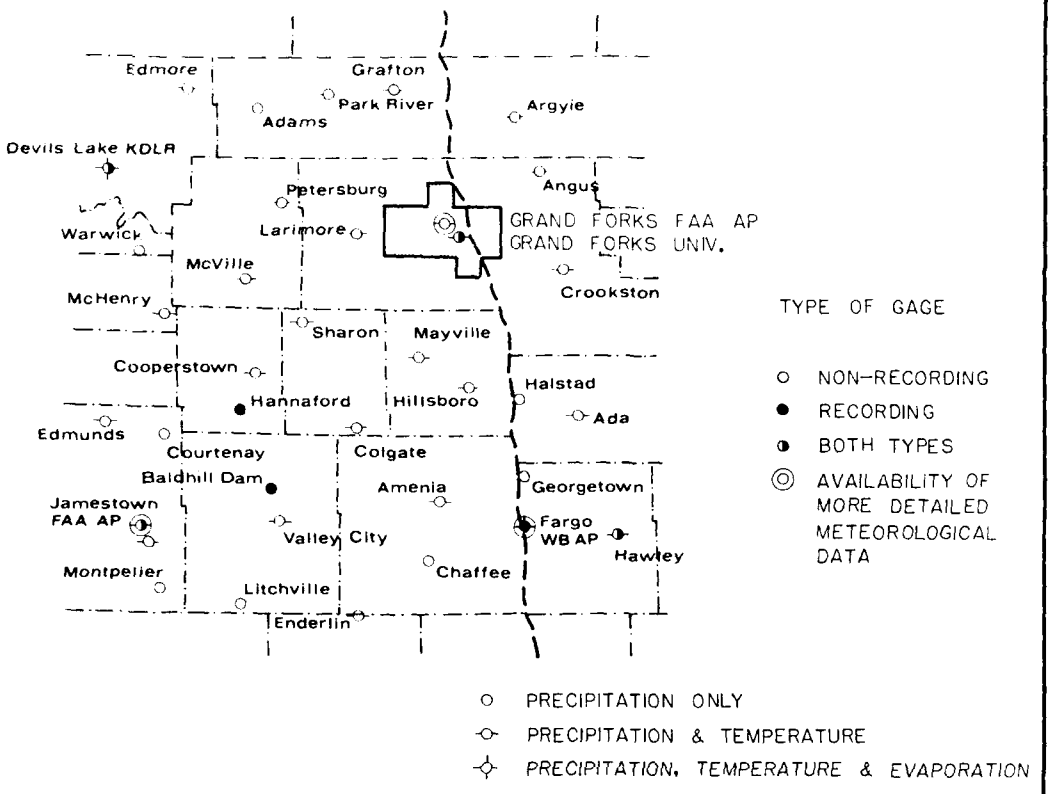


FIGURE 9

LOCATION OF WEATHER OBSERVATION STATIONS

SOURCE: REFERENCE NO. 37

The temperature changes which accompany the rapidly moving winter weather systems may be extreme and, when accompanied by blizzard conditions, may present a threat to the life and well-being of humans, farm animals and wildlife. The lowest temperature of record at the Grand Forks weather station, -44 degrees F, occurred on 1 February 1893, and the highest temperature of record, 109 degrees F, was recorded on 12 July 1936. The mean annual precipitation for the period of record at Grand Forks is 20.02 inches (Figure 10), making the city one of the "wetter" areas in North Dakota.

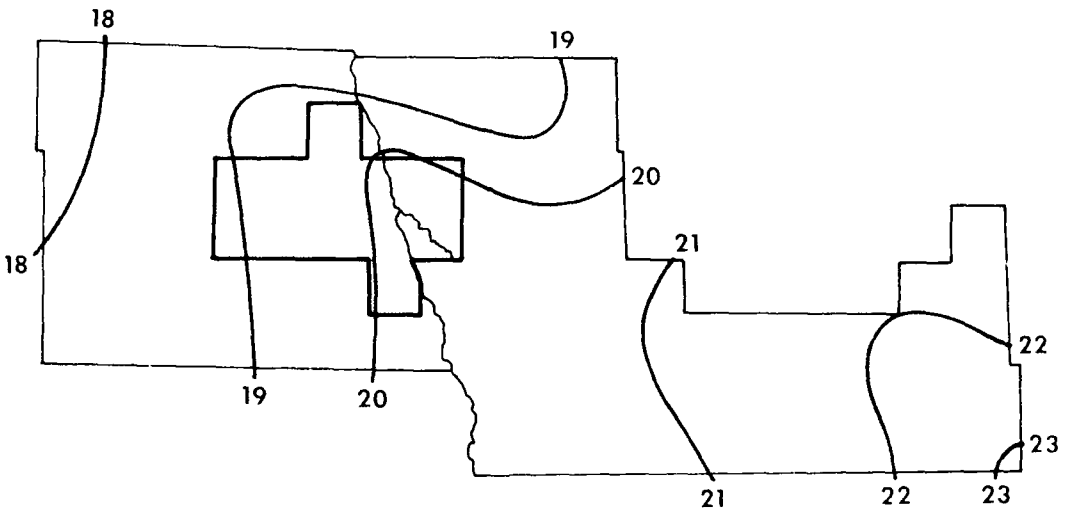


FIGURE 10

MEAN ANNUAL PRECIPITATION
IN GRAND FORKS AND POLK COUNTIES
(INCHES)

SOURCE: REFERENCE NO. 14 & 36

Average wind speeds in North Dakota are greatest in the winter and least in the summer. Average wind speeds in the Red River Valley range from 10 to 20 percent higher than in the adjacent plains area. As shown by the wind rose for the Grand Forks area (Figure 11), the greatest frequency and magnitude of prevailing annual winds are from the north and south.

Like other areas in the upper midwest and plains region, the Grand Forks-East Grand Forks area experiences tornadoes, windstorms and blizzards. A damaging tornado occurred at Grand Forks in 1887. In 1954, a major windstorm caused extensive damage and power blackouts in the area. An average of nearly 13 tornadoes occur in North Dakota during the year. The study area has experienced several severe blizzards over the years, the more memorable ones being the "Blizzard of 1896"; those in 1940; the "Ides of March Blizzard" in 1941, when winds hit 85 miles per hour at Grand Forks; and in 1950, when 70 mile an hour winds and heavy snow lashed the area.

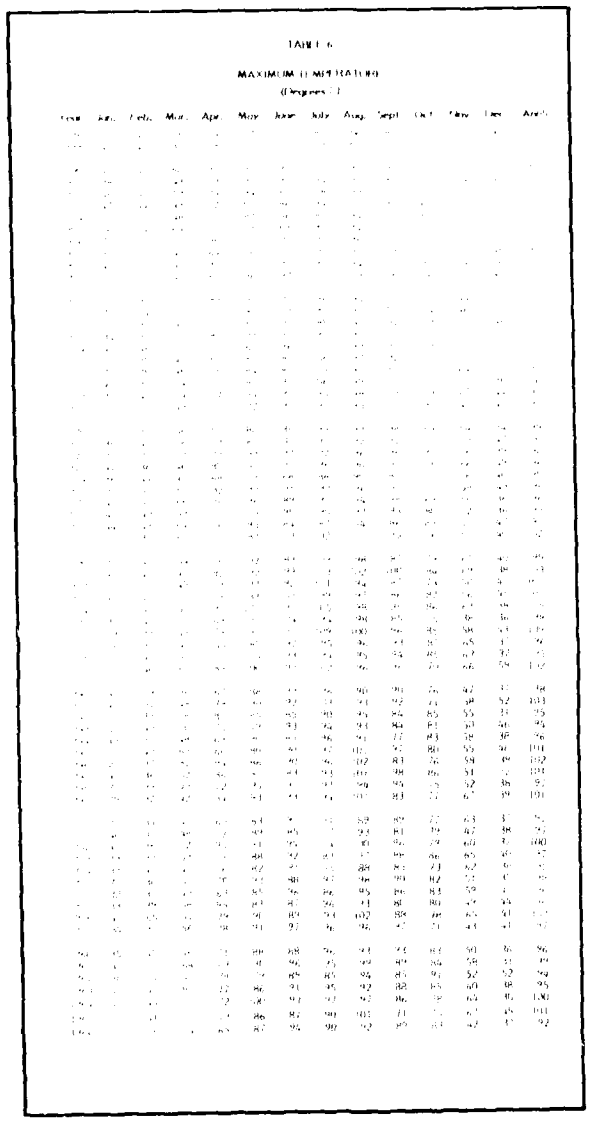
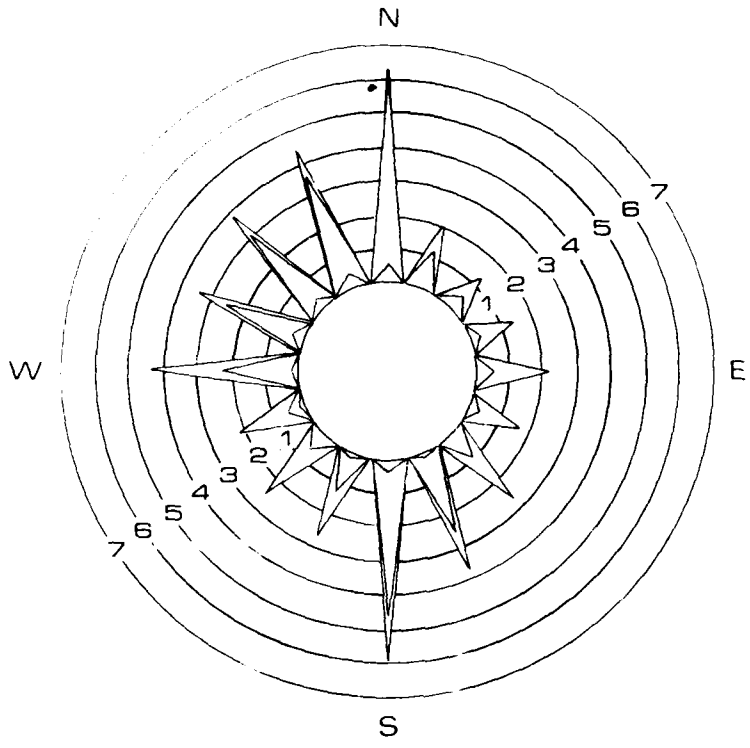


TABLE 7

MINIMUM TEMPERATURE
(Degrees F)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Ann'l
898	-15	-27	-6	15	25	36	39	40	29	22	-8	-31	-41
899	-28	-39	-14	25	38		44	40	27	22	15	-20	-39
900	-24	-28	-12	20	17	35	45	44	32	26	-12	-17	-28
901	-20	-18	-10	21	30	30		41	25	22	10	-33	-33
902	-33	-19	-13	15	30	40	45	42	25	20	2	-27	-33
903	-27	-32	0	18	26	34	38	40	27	20	-11	-25	-32
904	-37	-26	-16	10	32	40	40	40	25	21	1	-16	-37
905	-26	-30	-15	16	30	35	41	45	32	5	-35	26	-35
906	-29	-36	-17	20	21	40	44	35	30	5	-19	31	-36
907	-37	-39	-12	10	14	30	42	32	21	13	-1	-21	-39
908	-36	-29	-29	3	18	32	36	34	28	17	0	-22	-36
909	-38	-24	-6	7	18	33	45	37	32	10	-8	-27	-38
1910	-28	-25	9	16	21	28	41	33	28	16	-4	-25	-28
1911	-34	-27	-16	8	18	40	38	37	27	12	-24	-23	-34
1912	-43	-25	-15	21	30	37	38	39	24	17	15	-16	-43
1913	-37	-28	-23	23	25	35	41	47	22	5	6	-15	-37
1914	-21	-40	-10	13	25	38	49	39	32	19	-11	-28	-40
1915	-38	-9	-8	18	27	31	40	35	35	22	3	-19	-38
1916	-40	-36	-26	8	25	35	48	34	28	9	-2	-34	-40
1917	-36	-35	-33	20	25	28	40	36	22	2	10	-35	-36
1918	-35	-28	-3	13	19	38	43	44	23	24	10	-30	-35
1919	-36	-27	-20	19	26	39	47	38	29	-9	-24	-28	-36
1920	-32	-30	-22	-9	22	36	40	35	25	15	6	-24	-32
1921	-18	-20	-6	12	20	32	52	38	36	26	-23	-25	-25
1922	-36	-27	-14	22	40	46	46	40	33	14	6	-22	-36
1923	-26	-31	-20	14	20	39	49	34	24	12	7	-25	-31
1924	-33	-20	3	14	24	34	41	38	32	30	5	-29	-33
1925	-23	-32	-17	24	22	34	42	42	33	5	2	-16	-32
1926	-26	-5	-10	13	17	37	39	42	24	19	-12	-25	-26
1927	-28	-15	2	20	33	37	44	37	22	28	-7	-21	-28
1928	-22	-13	-9	7	27	31	48	38	24	13	9	-17	-22
1929	-32	-28	-6	19	26	37	44	39	18	23	-15	-27	-32
1930	-33	-23	-3	20	28	36	44	41	21	12	-8	-17	-33
1931	-14	-14	0	16	22	32	47	36	35	27	-4	-15	-15
1932	-24	-20	-13	6	26	47	44	38	33	17	-13	-18	-24
1933	-14	-33	-7	18	28	40	46	39	32	11	-5	-37	-37
1934	-29	-18	-7	19	26	41	47	36	26	21	7	-29	-29
1935	-35	-9	3	15	29	31	53	32	27	6	-16	-23	-35
1936	-39	-42	-22	-5	29	37	44	41	26	1	-11	-23	-42
1937	-36	-29	-5	17	28	36	48	44	28	16	-11	-27	-36
1938	-29	-23	-2	9	30	34	51	42	25	15	-15	-28	-29
1939	-28	-38	-19	6	22	38	42	44	24	19	7	-10	-38
1940	-25	-16	-15	4	26	32	41	44	27	25	-8	-21	-25
1941	-26	-31	-16	18	25	34	43	36	30	12	-3	-11	-31
1942	-26	-24	9	15	29	39	42	35	18	9	-7	-28	-28
1943	-36	-27	-18	17	25	35	50	40	27	15	4	-15	-36
1944	-12	-23	-16	3	25	39	39	40	33	20	2	-13	-23
1945	-26	-15	-10	16	20	49	43	41	24	15	-1	-29	-29
1946	-27	-29	-4	24	22	34	44	45	36	24	-8	-24	-29
1947	-22	-19	-5	22	24	39	41	43	24	26	-16	-23	-23
1948	-35	-31	-36	1	30	40	49	47	37	16	-4	-25	-36
1949	-29	-27	-15	16	30	36	45	42	24	18	1	-19	-29
1950	-33	-29	-24	-3	28	37	40	37	37	24	-10	-22	-33
1951	-36	-26	-11	22	28	39	43	45	28	10	-16	-29	-36
1952	-33	-15	-18	20	28	39	43	42	33	11	-1	-3	-33
1953	-19	-16	-10	12	27	32	47	46	33	26	14	-22	-22
1954	-32	-9	-2	-1	26	38	39	41	31	21	3	-10	-32
1955	-21	-28	-23	29	23	44	45	42	11	14	-15	-30	-30
1956	-22	-28	-23	14	29	35	47	41	25	18	-1	-23	-28
1957	-30	-17	-8	9	29	37	49	41	24	15	-1	-18	-30
1958	-16	-26	5	10	18	36	47	42	32	25	-22	-20	-26
1959	-26	-30	-3	22	29	42	46	48	28	14	-6	5	-30
1960	-22	-21	-18	14	27	40	42	49	32	21	-6	-22	-22
1961	-27	-20	11	10	22	40	46	45	26		-2	-18	-27
1962	-31	-32	-28	7	28	39	46	46	31	18	10	-16	-32
1963	-28	-22	-5	17	25	43	49	44	37	29	4	-27	-28
1964	-23	-18	-12	11	31	29	49	37	29	23	-19	-25	-25
1965	-30	-21	-12	27	30	43	43	34	23	27	-1	-13	-30
1966	-33	-34	-9	21	25	37	50	45	31	18	-2	-21	-34



% 4-10 KNOTS
% 11-21 KNOTS
% 22-33 KNOTS

PERCENTAGE TIME WIND HAS INDICATED DIRECTION AND SPEED
9.2% OF THE TIME WIND SPEED IS 3 KNOTS OR LESS

FIGURE 11

WIND ROSE
PERCENTAGE FREQUENCY OF WIND DIRECTION AND SPEED

SOURCE: REFERENCE NO. 38

TABLE 8

MEANS AND EXTREMES FOR PERIOD 1898 - 1966

Month	Temperature (°F)								Mean degree days	Precipitation Totals (Inches)								Mean number of days					Month
	Means			Extremes									Snow, Sleet					Precip. .10 inch or more	Temperatures				
	Daily maximum	Daily minimum	Monthly	Record highest	Year	Record lowest	Year			Mean	Greatest daily	Year	Mean	Maximum monthly	Year	Greatest daily	Year		Max. 90° and above	Max. 32° and below	Min. 32° and below	Min. 0° and below	
(a)	69	69	69	74		74			30	69	69		69	69		69		69	69	69	69	69	
J	34.1	15.5	24.8	61	1942	-43	1912	1576	.53	.64	1941	6.2	19.3	1950	9.0	1936	2	0	27	31	21	J
F	37.5	17.5	27.4	65	1955	-44	1933	1376	.54	.57	1911	5.5	19.6	1943	11.0	1943	2	0	23	28	16	F
M	47.9	25.6	36.8	84	1910	-36	1948	1314	.90	1.20	1937	5.9	29.0	1966	11.5	1966	2	0	15	29	6	M
A	61.4	36.7	49.1	95	1952	0	1920	717	1.56	3.45	1905	3.0	16.7	1950	6.5	1904	4	*	2	19	*	A
M	72.3	47.2	59.8	105	1934	14	1907	341	2.47	2.48	1922	0.4	6.7	1924	4.1	1939	5	1	0	6	0	M
J	81.6	57.0	69.3	105	1933	28	1917*	105	3.47	3.80	1905	T	T	1952*	T	1952*	7	2	0	*	0	J
J	84.5	60.8	72.7	109	1936	36	1909	31	2.39	2.93	1960						6	4	0	0	0	J
A	83.7	59.2	71.5	102	1955*	32	1935*	43	2.81	3.85	1951						5	4	0	*	0	A
S	77.5	52.6	65.1	100	1931	21	1955*	252	2.08	3.03	1957	T	2.0	1912	2.0	1912	4	1	0	3	0	S
O	66.1	41.6	53.9	95	1922	-9	1919	605	2.29	2.73	1934	1.1	5.2	1926	7.5	1926	3	0	1	14	*	O
N	49.6	27.9	38.8	72	1903	-35	1925	1167	.86	1.45	1956	5.9	24.1	1951	12.0	1958	2	0	12	28	3	N
D	38.2	19.9	29.1	66	1939	-47	1933	1640	.62	.85	1958	6.1	37.6	1918	9.6	1942*	2	0	25	31	14	D
Year	60.2	38.3	49.3	109	July 1936	-44	Feb. 1893	9676	20.02	3.85	Aug. 1951	34.9	37.6	Dec. 1918	12.0	Nov. 1958	44	12	105	186	60	Year

(a) Average length of record, years.

T Trace, an amount too small to measure.

** Base 65°F

* Also on earlier dates, months, or years.

* Less than one half.

TABLE 9

Total Precipitation (Inches)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Ann'l
[illegible]	.20	.56	.57	4.16	2.32	6.09	3.76	1.35	[illegible]	1.33	T	.50	23.19
[illegible]	.60	.30	.60	4.20	6.11	[illegible]	2.10	1.55	.42	1.55	[illegible]	.40	24.65
1900	.11	.22	.15	1.22	.25	[illegible]	1.12	6.99	1.40	2.41	.67	.20	20.04
1901	.61	.30	.65	2.06	.29	4.47	4.16	5.40	1.55	2.21	.34	.71	26.40
1902	.31	.55	1.14	2.46	1.55	2.09	2.94	3.15	2.01	1.36	.32	.46	22.00
1903	.20	.10	.13	.75	1.45	.49	3.18	4.02	3.65	1.95	.60	1.05	23.79
1904	.36	1.10	1.05	1.53	1.76	5.64	2.63	2.79	.11	1.49	T	.43	20.40
1905	.25	.11	2.55	.96	3.15	1.47	5.49	4.54	1.62	.28	.75	.28	25.17
1906	.70	.30	.29	1.96	3.05	1.06	2.55	1.09	2.61	.49	1.73	.47	24.15
1907	.90	.30	.20	.11	.67	4.63	2.99	1.66	1.57	.64	.05	.30	15.97
1908	.13	1.95	.40	.86	3.71	2.70	[illegible]	2.41	.50	1.06	.35	.21	22.40
1909	.65	.10	.27	.90	1.60	[illegible]	.96	2.59	.62	.45	.75	.15	19.42
1910	.20	.11	1.22	.46	[illegible]	.63	.64	.89	3.14	.26	.67	.40	9.38
1911	.48	1.77	.24	2.82	3.28	4.57	2.06	1.30	1.22	1.40	1.20	.53	23.18
1912	.96	.05	.26	1.65	2.92	1.19	4.59	2.56	5.97	.23	.10	.42	20.75
1913	.27	.60	.40	[illegible]	[illegible]	1.21	2.76	1.58	[illegible]	1.61	.43	.06	24.33
1914	.75	.14	.65	2.13	2.21	[illegible]	4.13	3.17	.34	1.80	.45	.49	23.31
1915	.47	1.27	.19	.61	3.36	7.34	2.25	.07	1.57	.24	1.00	.62	19.40
1916	1.56	.65	1.90	1.76	2.59	5.40	[illegible]	3.57	1.19	.64	.01	1.66	[illegible]
1917	.64	1.12	.34	1.37	.21	5.97	2.54	3.56	.44	1.15	.24	1.27	[illegible]
1918	.50	.27	.04	2.55	1.20	.79	4.06	3.94	.16	.20	1.03	2.29	[illegible]
1919	.45	.45	.71	3.15	4.62	2.35	4.16	2.96	2.23	.52	2.21	.22	23.01
1920	1.37	.25	.61	.60	2.03	1.49	1.32	.24	3.10	.49	.58	.42	12.93
1921	.34	[illegible]	.78	4.12	1.69	2.14	4.09	3.53	3.44	.50	.30	.47	18.21
1922	.52	1.96	1.06	.77	[illegible]	1.91	3.50	2.41	2.12	.20	3.30	1.61	27.93
1923	.25	.76	.65	1.26	2.73	2.27	3.41	3.21	[illegible]	.34	.65	.46	16.56
1924	.61	.31	.31	3.45	2.38	2.07	1.56	1.43	3.19	2.46	.27	.56	20.52
1925	.20	.35	1.12	1.56	[illegible]	9.53	3.12	1.96	4.23	.99	.35	.26	25.03
1926	[illegible]	.26	.45	.25	2.45	4.40	1.53	1.63	1.79	4.07	2.20	.37	24.57
1927	.33	.63	.54	2.30	5.05	3.59	1.65	5.97	.26	1.64	.42	.62	25.20
1928	.29	.01	1.60	.19	.60	5.06	4.69	3.05	.48	.33	1.13	.47	19.13
1929	.74	.19	.85	1.70	2.11	1.56	2.66	1.16	1.49	2.34	.75	.65	16.39
1930	[illegible]	1.59	.43	1.74	4.21	3.60	1.75	1.24	1.43	1.90	3.09	.79	21.39
1931	.14	.29	1.04	.15	2.87	2.93	2.79	2.01	2.44	3.65	1.27	.14	19.49
1932	.34	.97	.55	2.48	2.30	2.27	1.93	2.97	1.06	2.74	.69	.07	17.67
1933	1.06	.13	.40	1.41	2.81	2.01	1.55	.44	2.90	1.33	1.35	1.47	15.36
1934	.25	.11	.29	.91	.90	3.70	.93	1.39	.06	4.21	.65	.53	14.75
1935	[illegible]	.21	.99	2.00	1.61	2.61	6.14	4.32	.75	.24	1.13	.72	21.69
1936	.60	1.09	1.69	.40	1.00	2.26	.66	.49	1.27	.23	.12	.30	9.91
1937	.54	.18	.29	4.62	3.33	2.90	4.66	2.24	.46	.19	3.24	.53	23.01
1938	.31	.98	.84	1.43	5.03	2.07	3.73	1.22	1.14	.52	1.06	.63	14.86
1939	.63	.96	.73	.99	.91	4.58	1.37	1.89	2.22	1.73	.33	.40	16.67
1940	.12	1.09	.83	1.49	1.71	.65	4.12	2.09	.73	2.27	.83	.88	19.14
1941	1.25	.53	.98	2.34	1.02	7.72	.94	4.66	4.85	1.44	.13	.21	26.60
1942	.15	.14	1.76	2.29	2.58	1.94	2.55	4.47	.79	.34	.44	1.15	17.63
1943	.27	1.07	.52	1.03	3.55	2.70	3.44	1.07	.63	.74	.45	.30	17.31
1944	.96	.09	2.29	.70	1.35	4.83	2.16	12.16	1.30	.16	2.96	.37	29.57
1945	.60	.53	1.16	1.76	1.32	4.61	2.79	2.10	1.99	.44	.13	1.24	20.86
1946	.63	.73	2.29	.43	2.03	4.60	.76	4.06	3.31	2.62	.90	.45	21.47
1947	.51	.60	[illegible]	2.34	1.45	5.95	1.13	3.15	1.77	1.05	2.04	.55	23.69
1948	.37	1.17	.90	1.19	.79	1.46	4.40	4.47	.73	.86	.93	1.05	25.08
1949	1.69	.66	.96	.07	4.63	2.15	3.56	[illegible]	.69	3.08	.70	1.29	23.61
1950	1.17	.05	3.11	2.05	4.00	[illegible]	1.63	1.11	5.56	1.05	.49	.53	24.37
1951	.60	.43	.68	.55	.16	[illegible]	1.94	[illegible]	2.35	.34	.91	1.16	19.68
1952	.70	.54	.20	.16	.34	3.41	3.09	1.92	.45	[illegible]	1.55	.16	17.63
1953	.15	.67	.17	2.78	3.47	[illegible]	[illegible]	[illegible]	3.72	1.11	.55	.37	14.64
1954	.43	.14	.70	[illegible]	2.06	[illegible]	1.94	2.76	1.99	.60	.49	.27	17.37
1955	.45	.96	.97	.41	3.10	4.37	1.02	2.99	1.19	[illegible]	1.12	.38	21.51
1956	1.10	.41	1.33	.34	3.05	2.95	1.61	5.19	.33	1.45	1.30	.63	19.63
1957	.30	[illegible]	.13	.98	3.22	2.79	2.20	4.26	1.56	1.94	.83	.11	25.67
1958	.09	.15	.15	[illegible]	[illegible]	2.85	5.09	1.12	1.24	1.27	3.16	.43	17.42
1959	.25	.63	.08	[illegible]	2.98	[illegible]	3.53	2.94	1.14	1.18	1.04	.26	19.99
1960	.64	.51	.27	1.58	1.49	2.90	3.77	3.76	3.64	1.70	.60	.65	19.89
1961	.36	.39	.75	1.96	.83	1.53	4.44	1.44	4.35	2.21	.60	.55	18.69
1962	.74	1.12	1.45	.36	4.12	3.47	1.91	3.76	4.00	.39	.44	.59	20.84
1963	.07	.20	.30	2.18	1.32	1.92	3.76	.63	.64	.64	.23	.75	13.00
1964	.50	.36	.93	5.10	2.27	9.30	2.18	3.90	4.73	.33	.64	.90	27.37
1965	.19	.38	.39	3.55	3.75	4.40	3.73	3.15	6.35	1.60	1.71	.94	27.60
1966	.35	.46	1.99	1.26	1.13	3.32	7.40	2.60	.64	.79	.16	1.03	20.91

TABLE 10

MONTHLY AND SEASONAL SNOWFALL

Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
1898					1.0	8.6	5.7	0	0	0	M
1898 - 1899	0	T	T	5.0	6.0	1.0	6.0	0	0	0	18.0
1899 - 1900	0	T	1.5	5.0	1.1	2.7	3.5	0	0	0	13.8
1900 - 1901	0	0	8.0	2.0	M	2.0	6.5	1.5	T	0	M
1901 - 1902	0	0	2.4	7.1	3.1	3.9	4.5	6.0	1.5	0	28.5
1902 - 1903	0	0	1.3	4.6	7.0	1.0	5.0	0	0	0	18.9
1903 - 1904	0	0	5.0	10.5	3.0	11.0	7.6	7.3	0	0	44.6
1904 - 1905	0	0	T	4.3	3.0	1.3	2.5	0	0	0	11.1
1905 - 1906	0	1.0	6.0	2.8	7.0	2.0	1.0	0	0.5	0	20.3
1906 - 1907	0	4.0	15.6	8.7	9.0	1.0	2.0	1.1	0	0	40.4
1907 - 1908	0	0	0	3.0	1.3	14.0	9.0	0.2	0	0	27.5
1908 - 1909	T	0	3.4	2.5	8.6	1.0	2.7	3.0	0	0	21.2
1909 - 1910	0	T	7.5	7.5	2.0	1.3	T	2.0	0	0	20.3
1910 - 1911	0	0	7.0	4.0	9.1	13.8	0.3	7.5	0	0	41.7
1911 - 1912	0	T	9.5	5.3	7.1	0.5	2.9	0	0	0	25.3
1912 - 1913	2.0	0.2	1.0	4.5	3.1	1.0	7.4	3.0	0	0	22.2
1913 - 1914	0	0.5	1.5	0.5	6.8	3.5	5.0	1.6	0	0	19.4
1914 - 1915	0	0	2.4	4.9	4.8	12.2	0.8	0	0.1	0	25.2
1915 - 1916	0	T	2.7	6.5	17.5	7.1	17.3	6.1	T	0	57.2
1916 - 1917	0	1.8	0.1	16.9	6.8	10.8	3.6	0.7	0.3	0	41.0
1917 - 1918	0	6.6	2.4	12.9	5.0	2.6	0	T	0	0	29.5
1918 - 1919	0	1.0	5.7	27.6	5.2	5.0	1.2	8.1	0	0	53.8
1919 - 1920	0	5.0	23.9	1.9	10.3	2.5	3.9	1.2	0	0	48.7
1920 - 1921	0	T	1.3	3.5	1.7	7.5	7.3	1.2	T	0	24.5
1921 - 1922	0	3.0	3.6	3.5	5.2	19.6	7.6	0.8	0	0	43.3
1922 - 1923	0	0.6	7.1	10.1	2.8	7.6	6.5	9.1	0.1	0	44.1
1923 - 1924	0	0.8	1.2	9.5	9.2	4.2	5.4	3.2	6.7	0	40.2
1924 - 1925	0	T	2.2	2.7	2.0	3.3	4.9	0	T	0	15.1
1925 - 1926	0	5.4	0.1	2.2	4.5	2.5	3.0	0.4	0	0	18.1
1926 - 1927	T	8.2	12.7	6.5	4.1	5.9	4.3	5.0	0	0	46.7
1927 - 1928	T	1.4	7.5	6.3	3.6	0.1	10.2	5.0	0	0	34.1
1928 - 1929	T	0	T	7.4	11.2	2.6	1.5	2.3	T	0	24.9
1929 - 1930	0	5.2	6.9	6.7	4.1	17.9	3.3	T	T	0	44.1

Season	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	Total
1930 - 1931	0	0.4	8.2	8.4	1.4	1.0	3.4	T	0.8	0	23.6
1931 - 1932	0	0	10.9	2.3	5.4	10.3	6.7	1.8	0	0	37.4
1932 - 1933	0	5.8	0.5	0.8	11.6	1.5	2.2	11.4	0	0	39.8
1933 - 1934	0	4.4	16.8	14.4	1.3	1.2	2.8	8.2	0	0	49.1
1934 - 1935	T	T	2.2	5.7	6.3	0.1	4.6	3.8	T	T	22.7
1935 - 1936	0	1.5	11.7	7.7	10.5	13.1	6.6	1.7	0	0	52.8
1936 - 1937	0	1.7	3.2	3.0	13.5	8.6	3.2	9.6	0	0	42.8
1937 - 1938	0	0	7.5	5.6	3.0	10.4	0.7	0.7	4.3	0	32.2
1938 - 1939	0	0	15.2	6.0	6.6	10.2	8.8	1.7	0	0	48.5
1939 - 1940	0.2	2.3	0.1	1.3	1.1	30.8	6.3	3.8	0	0	25.9
1940 - 1941	0	0	5.9	8.0	10.4	5.8	8.5	2.3	0	0	40.9
1941 - 1942	0.2	3.6	1.6	3.0	2.1	1.9	15.6	1.7	T	0	29.7
1942 - 1943	0	T	3.6	13.3	2.7	19.6	12.2	T	T	0	51.4
1943 - 1944	0	T	3.0	4.2	5.1	1.9	18.5	T	1.0	0	33.7
1944 - 1945	0	0	7.4	3.5	8.6	5.9	1.7	4.5	3.5	0	35.1
1945 - 1946	T	T	1.2	16.7	5.9	9.0	2.3	5.5	1.0	0	41.6
1946 - 1947	0	T	4.3	4.8	6.3	3.9	4.2	3.0	0.3	0	26.8
1947 - 1948	0	0	21.0	6.5	5.1	13.2	9.5	10.4	0.5	0	66.2
1948 - 1949	0	T	6.4	9.5	16.9	7.9	10.1	T	T	T	50.8
1949 - 1950	0	0.9	2.8	13.3	19.3	1.4	10.5	16.7	4.6	T	69.4
1950 - 1951	T	2.0	4.7	7.0	7.2	2.2	9.5	1.0	0	0	33.6
1951 - 1952	0	0.3	6.4	8.9	12.0	6.0	2.8	T	0	T	38.4
1952 - 1953	0	T	1.5	4.9	6.5	4.7	3.5	1.7	T	0	22.8
1953 - 1954	0	0	7.0	6.8	11.4	0.9	4.6	T	2.5	0	33.2
1954 - 1955	0	0.5	3.1	1.5	4.7	11.3	13.4	0.5	0	0	35.0
1955 - 1956	0	0.5	13.1	4.4	11.9	6.3	15.3	1.8	0	0	53.3
1956 - 1957	0	0	T	7.9	5.4	7.5	0.9	4.0	0	0	25.6
1957 - 1958	0	0.5	5.8	1.6	1.6	0.6	2.8	T	0	0	12.9
1958 - 1959	0	0	24.1	4.1	4.4	7.6	1.4	0.5	0	0	42.1
1959 - 1960	0	3.8	9.9	0.6	8.1	4.7	2.2	13.5	T	0	42.8
1960 - 1961	0	0	6.9	8.0	4.1	6.0	2.4	1.0	T	0	29.4
1961 - 1962	0	0	5.7	6.8	9.2	10.6	16.3	0.7	0	0	47.3
1962 - 1963	0	T	6.2	7.1	1.0	5.5	5.4	2.0	T	0	27.2
1963 - 1964	0	0	3.8	11.0	6.0	3.6	11.2	7.9	0	0	41.7
1964 - 1965	0	0	7.0	10.2	2.8	1.1	4.3	5.0	T	0	30.4
1965 - 1966	0	0	13.2	7.1	4.6	2.9	10.0	3.9	0	0	49.7
1966 -	0	0	2.9	10.7							

TABLE II

PROBABILITY OF FREEZE OCCURRENCE IN SPRING

Percent probability of a freeze occurring after date shown

Temp. (Degrees F)	90%	75%	50%	25%	10%
32	May 5	May 12	May 19	May 26	June 2
28	Apr. 22	Apr. 29	May 6	May 13	May 20
24	Apr. 8	Apr. 16	Apr. 24	May 2	May 10
20	Mar. 28	Apr. 5	Apr. 13	Apr. 22	Apr. 29
16	Mar. 19	Mar. 27	Apr. 5	Apr. 14	Apr. 22

PROBABILITY OF FREEZE OCCURRENCE IN FALL

Percent probability of a freeze occurring before date shown

Temp. (Degrees F)	10%	25%	50%	75%	90%
32	Sep. 11	Sep. 17	Sep. 23	Sep. 29	Oct. 5
28	Sep. 16	Sep. 22	Sep. 29	Oct. 6	Oct. 12
24	Sep. 26	Oct. 4	Oct. 12	Oct. 20	Oct. 28
20	Oct. 8	Oct. 16	Oct. 25	Nov. 3	Nov. 11
16	Oct. 15	Oct. 23	Nov. 1	Nov. 10	Nov. 18

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Grand Forks
East Grand Forks

URBAN WATER RESOURCES STUDY

Technical Elements

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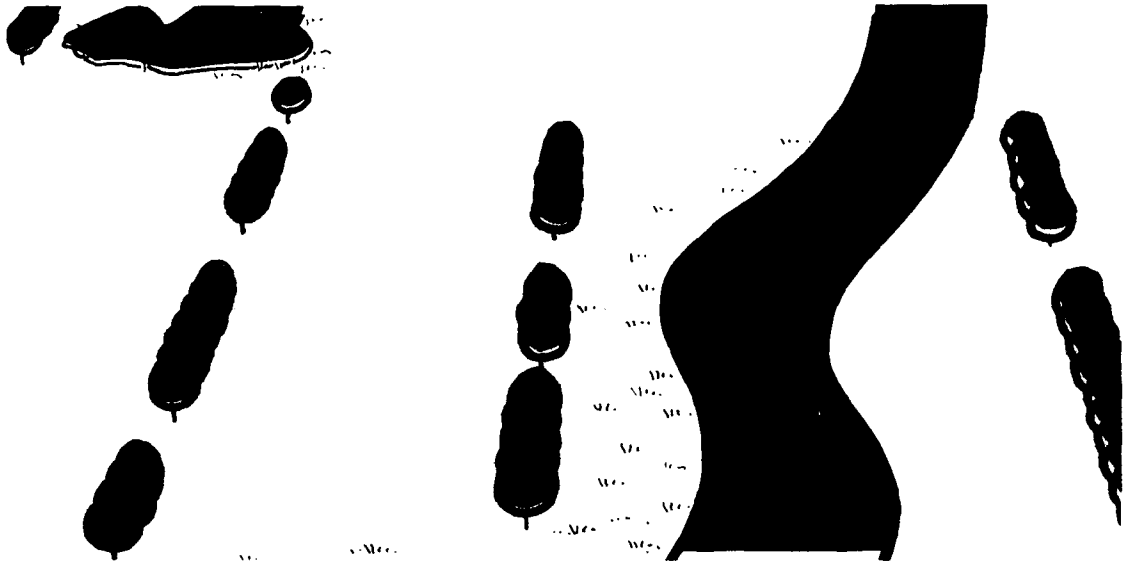

BIOLOGICAL ELEMENTS

Introduction

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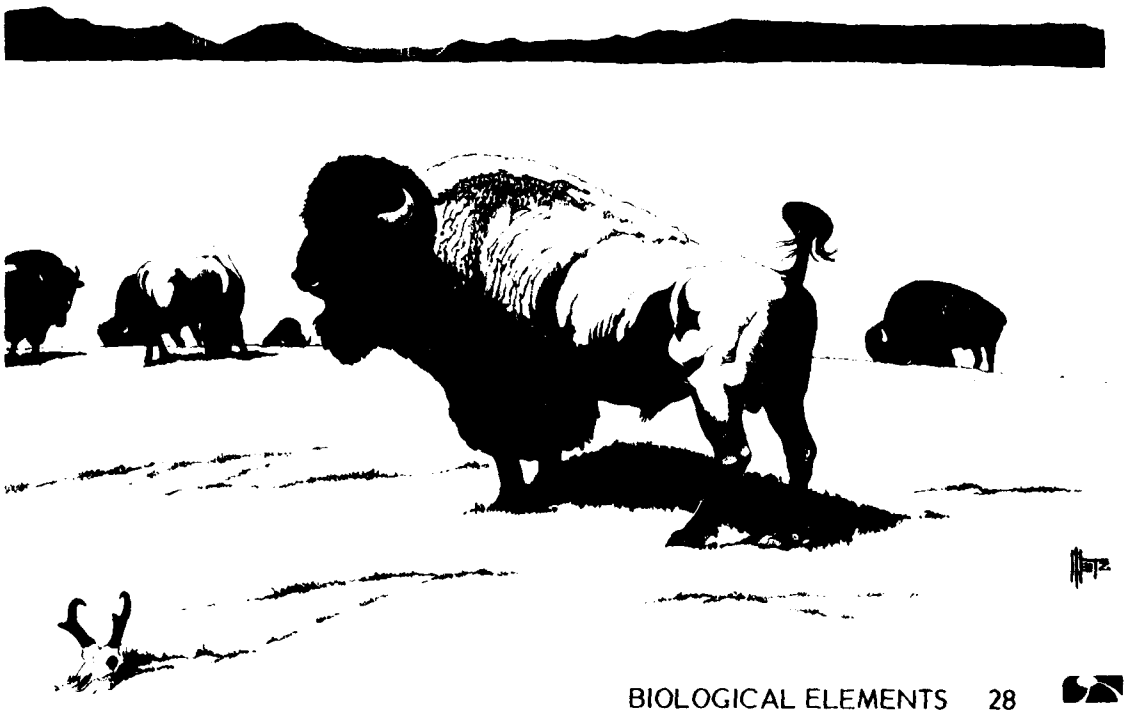
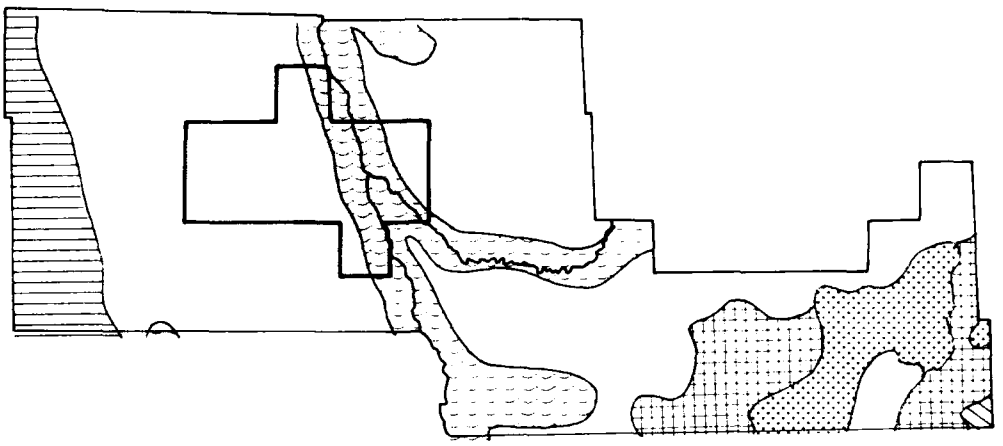
INTRODUCTION

About 12,000 years ago, the Grand Forks-East Grand Forks area was covered by extensive forest growth. Drier conditions some 3,000 years later caused an increase in prairie vegetation. In about 500 years, prairie vegatation became dominant in the former lake plain area, with oak savanna forests in the eastern upland areas. Following another period of apparent reforestation some 4,000 years ago, the prairie ecosystem again achieved dominance and remained relatively undisturbed until the influx of settlers in the mid-19th century.

To the earliest explorers and settlers in the area, the virgin prairie in bloom must have been very attractive. Dominant grass species at that time included the tall and medium prairie grasses, such as big bluestem, wheatgrass, prairie June grass and species of bluegrass, as well as switch grass and Indian grass. Flowering species included wild columbine, buttercups, violets, asters and goldenrods. Reed grasses, sedges, cattails and bulrushes were found in the wet meadows and marshes. Shrub communities such as berry shrubs and leadplant occurred throughout the prairie. Typical floral associations in the region are shown on Figure 12.





BLUESTEM PRAIRIE
(ANDROPOGON-PANICUM-SORGHASTRUM)
OAK SAVANNA
(QUERCUS-ANDROPOGON)
WHEATGRASS-BLUESTEM-NEEDLEGRASS
(AGROPYRON-ANDROPOGON-STIPA)
NORTHERN FLOODPLAIN FOREST
(POPULUS-SALIX-ULMUS)
OAK-MAPLE-BASSWOOD FOREST
(QUERCUS-ACER-TILIA)
GREAT LAKES SPRUCE-FIR FOREST
(PICEA-ABIES)

FIGURE 12

FLORA ASSOCIATIONS OF GRAND FORKS AND POLK COUNTIES

SOURCE: REFERENCE NO. 53

Buffalo roamed the area during early periods and were a principal food source for the Indians. To aid in hunting buffalo (bison), the Indians burned the prairie. These fires and natural fires started by lightning burned the dry grasses, improving soil fertility and pasture for the buffalo. Fires, along with the dry conditions and dense prairie ground cover, resisted the encroachment of the forest. The first white settlers found woodlands only along the major watercourses. These floodplain forests included bur oak, hackberry, American elm, basswood, and green ash.

The rich prairie grasslands in the Lake Agassiz region supported a variety of wildlife. Buffalo and elk were common. Other species included the coyote and prairie grouse. Migrating waterfowl frequented wetlands in the area.

The boundary or transition between the floodplain forest and treeless prairie communities is defined as an ecotone. Species common to each community or ecosystem overlap at this boundary, with the boundary area containing more and different species than either ecosystem. Species from the native prairie ecosystem, whose distribution ended at or near the prairie-forest ecotone, included the Hungarian partridge, prairie chicken and sharp-tailed grouse. Species in the forest community included the cottontail rabbit, deer, squirrel and wood duck.

The influx of settlers into the area during the early and mid-1800's drastically and permanently altered the characteristics of the prairie biome. Cultivation of the fertile prairie soils signaled the end of most native prairie grasses and eliminated or threatened the traditional residents. By 1870, the buffalo were gone as a result of the hunters or loss of supporting native pasture. Former residents, such as the black bear, badger, antelope and elk, are either gone from the area or near extinction. The drainage of wetlands and potholes in the poorly drained lake plain area has resulted in a substantial loss of waterfowl and other semiaquatic inhabitants.

Much of the original bluestem prairie has disappeared with only remnant surviving tracts (see Wildlife Habitat Plate, Plate 6). Shelterbelts of both native and exotic tree and shrub species crisscross the former prairie to provide protection against wind. The visual landscape is also markedly altered by the numerous utility transmission lines traversing the area. In contrast to the marked prairie changes, the floodplain forest species do not appear to have been significantly altered. Past lumbering activity took the larger, mature trees but in turn provided regrowth valuable to resident wildlife. Cultural development such as city park areas has eliminated the natural understory and ground cover in some areas.

ECOSYSTEMS

During the formation of Lake Agassiz about 12,000 years ago, the Grand Forks-East Grand Forks area was covered by forests consisting largely of spruce, larch, poplar, ash and, later, paper birch. Between 10 and 11,000 years ago, the climate, which had been cool and moist, warmed, and birch, elm, pine and oak migrated into the region. Beginning about 9,000 years ago, this expansion of pine and deciduous forests was interrupted by an increase in prairie, suggesting drier conditions. By 8,500 years ago, the prairie was dominant on the lowlands around the lake, with oak savanna in the eastern uplands. Lake Agassiz disappeared in a very dry period (7-8,000 years ago) which coincides with the appearance of Ambrosia. Climatic conditions 4,000 years ago were favorable for the deciduous forests of birch elm, poplar, ash, ironwood, basswood, and sugar maple. As Lake Agassiz drained, the prairie dominated the lowlands, while oak savanna, and later, deciduous and coniferous forests, developed in the eastern uplands. The continuum for the Prairie Counteau, within which the study area is located, is presented in Table 12.

TABLE 12

ECOSYSTEM CHANGES - PRAIRIE COUTEAU

Thousands of Years Before Present		
0	-	Prairie with local developing deciduous forest (Tilia, Fraxinus, Quercus, Ulmus, Populus, Salix)
1		
2		
3		
4		
5	-	Prairie (Gramineae, Artemisia, Petalostemum, Amorpha)
6		
7		
8		----------
9		Prairie expanding
10		Deciduous forest (Ulmus, Betula, Quercus, Acer, Pteridium)
11		
12	-	Spruce forest

Source: Reference 79

The fluctuations of glacial Lake Agassiz left the Red River Valley underlain by alluvial clays, modified drift, sand and gravel. The result was a strong subsoil which provided a foundation for the deep, rich topsoil and prairie grasses.

Prior to the arrival of the white settlers, the Grand Forks-East Grand Forks area was virgin prairie, with the exception of timbered portions adjacent to the Red River of the North and Red Lake River. The presettlement prairie was comprised of tall and medium grasses, including big bluestem, slender wheatgrass, western wheatgrass, prairie June grass, and species of bluegrass, as listed in Table 13.

TABLE 13

PRESETTLEMENT GRASS DISTRIBUTION

Distribution	Grasses
Slight depressions	Fowl bluegrass and eastern grasses
Wet areas (sloughs and ditches)	Cordgrass, American slough grass, sprangletop, manna grass, giant reed grass, reed canary grass, northern reed grass and sedges
Dry ridges and knolls	Blue grama, needle and thread, western wheatgrass, prairie June grass, little bluestem and dryland sedges
Rough land and broken hillsides	Little bluestem, plains muhly, blue grama grass, side oats grama, needle and thread, prairie June grass and bluebunch wheatgrass

Source: Reference 51

From early spring to late autumn, prairie flowers bloomed. Earliest came the pasque flower, followed by the wild columbine, buttercups, violets and spiderwort, beard-tongue, ragwort, asters and goldenrods. Prairie clover, a perennial herb, also occurred throughout the prairie. Wet meadows and marshes contained reed grass, arrowhead, cattail, sedges and bulrushes. Species of the aster, bean, rose and lily families added to the flora.

Shrub communities were scattered throughout the prairie in a variety of habitats. Low shrubs such as leadplant occurred throughout the prairie. Colonies of silverberry and wolfberry were prevalent on dry prairie slopes and knolls. Berry shrubs such as chokecherry and pin cherry occurred along the prairie-woodland fringe areas.

To aid in hunting buffalo, the Indians burned the prairie. Fires also started from lightning in the spring and fall, when grasses were tinder dry. The dead grasses burned so rapidly that a fire could spread 50 to 100 miles within a few days. Fires promoted soil fertility and improved the pasturage for buffalo. When fires ceased following settlement, forests expanded.

Currently there are two major ecosystems in the Grand Forks-East Grand Forks region: bluestem prairie, and northern floodplain forests (see Figure 12). Much of the original prairie has been plowed and is utilized for crop production, resulting in several agricultural communities. Wetlands, waters and urban areas comprise other ecosystems.

Prairie

Though much of the bluestem prairie is gone, native grasses survive on tracts owned by the University of North Dakota, in game management areas and along roadsides (Plate 6). Tall bluestem, switch grass, Indian grass and wild rye are common in such communities, where rainfall is abundant, and are often found in moist lowlands and deep ravines. Mid-grasses - little bluestem, needlegrass and June grass - are found in some areas. Silverberry and other small prairie shrubs also exist. Wildlife species include a variety of mammals and prairie birds, such as Hungarian partridge, prairie chickens and short-tailed grouse.

Northern Floodplain Forest

This rich woodland community occurs on the floodplain of the Red River and tributary streams in the study area. The mature forest stands are dominated by a variety of trees such as bur oak, hackberry, American elm, basswood and green ash. Ordinarily, a well-developed understory is composed of small trees and tall shrubs, including hop hornbeam and prickly ash.

This ecosystem provides a diverse habitat for cottontail rabbits, deer, squirrels, wood ducks and associated species. The habitat is extremely valuable to wildlife because of the proximity of cover and water to food sources, which are usually plentiful along field-forest borders.

Agricultural Communities

The study region is now a patchwork of agricultural croplands. Extensive acreage is devoted to growing sugar beets, potatoes, soybeans, small grains and sunflowers. Cropland comprises 81 percent of the total area of the Agassiz Lake Plain region. These acreages are practically devoid of wildlife. However, small grains and soybeans are important food sources to small mammals and birds which frequent the adjacent communities.

Northern Flood Plain Forest
Understory Removed

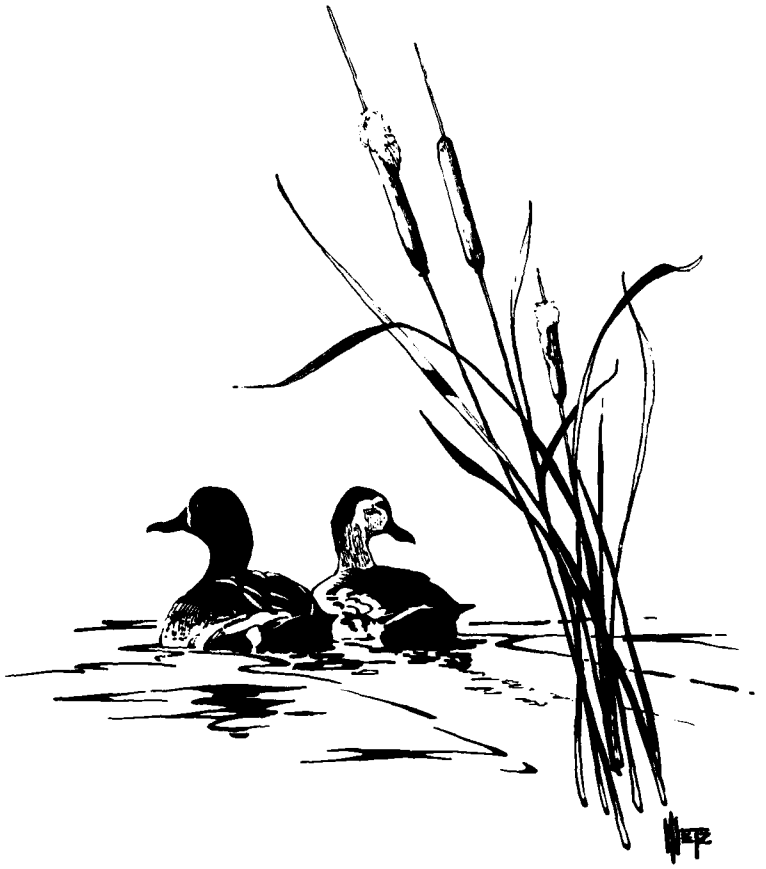
On many farms in the study area, trees and shrubs are planted in long narrow strips called shelterbelts to protect farmsteads from severe winter winds and impede drifting snow. Multiple row shelterbelts are preferred as habitat because their density allows for overwintering by small mammals and birds. The cover which they provide has great importance to wildlife which feed on resources of the shelterbelts and neighboring croplands.

In agricultural areas, narrow strips of disturbed habitat border fencerows, roadsides and drainage ditches. Vegetation on these areas is often composed of native prairie grasses and herbs, in combination with many introduced weeds characteristic of disturbed soils. Many of these uncultivated areas are burned annually and have little wildlife value. Occasional native trees or shrubs also are present. Diverse seed sources and grasses encourage birds and small burrowing mammals, in addition to the raptors which prey upon them.

Typical Roadside Vegetation

Wetlands

Wetlands have nearly disappeared. Since 1870, when early settler-historians reported numerous waterfowl in the area, most of the wetlands have been drained for agriculture, while those near urban areas were filled. The original wetlands, located between the successive beaches of glacial Lake Agassiz, have given way to oxbow marshes, scattered wetlands and waterfowl refuge/production areas. Generally, wetlands are recognized by their standing water and emergent vegetation, such as sedges, arrowhead, cattail, bladder pods, pond lilies, flattop asters and violets. Stewarts Slough and Kellys Slough National Wildlife Refuge are important wetland areas in or near the study region. A large number of waterfowl pass through these areas during spring and fall migrations.



Open Waters

Aquatic ecosystems vary from salt water to fresh water farm ponds to rivers. Most important are the Red River of the North and Red Lake River, but most common are tributary streams and drainage ditches. Because most waters are near croplands, bank vegetation is often absent and erosion is advanced, with resultant sedimentation of the stream channel. Rough fish species can optimize these conditions and thus appear in greater numbers than sport fish.

Urban Areas

The urban environment has little vegetative diversity, coupled with meager cover and food resources. Rabbits, squirrels and birds are inhabitants of an ecosystem dominated by landscaped lawns, ornamental trees and shrubs, graveled driveways and streets. Many species of song birds appear to thrive in the urban community. White tailed deer, red fox, raccoon and skunk occasionally stray from shelterbelts and the Red River forest corridor into urban areas. Typical habitat niches are buildings, lawns, parks and golf courses, garden plots and streets.

FLORA

The flora of the Grand Forks-East Grand Forks area falls into three categories: trees, shrubs, and herbs. Trees dominate the Red River floodplain forest and shelterbelts. Shrubs thrive as understory in the floodplain forest, in shelterbelts and in the urban environments. Herbs are found on the forest floor, grasslands and wet areas.

Trees

Good stands of cottonwood, elm, ash and box elder thrive in the moist, alluvial soils of the Red River of the North and Red Lake River bottomland, where adequate moisture promotes good form, quality and size of timber stands. Common tree species in the study area floodplains include basswood, elm, box elder and ash. Basswood flourishes farther from the river, whereas box elder thrives nearer to the river. Waterleaf, wood nettle, bedstraw and columbine typify the floodplain ground cover. Buckbrush, hawthorne and gooseberry typify the understory.

The forest resources of the study area, meager in any prairie biome, have been reduced by land clearing for agricultural and urban development. Of a total land area of 920,000 acres in Grand Forks County, only 19,500 acres or 4.7 percent were commercial forest in 1956 (Reference 64). A similar Federal survey of Polk County forest lands in 1962 revealed that, of the total county land area of 1,287,700 acres, 74,500 acres or 6 percent were commercial forest.

Most forestry activities in North Dakota are focused on planting trees in groves and strips. State and Federal agencies have encouraged planting programs directed toward establishing shelterbelts and windbreaks. Protection of homes, livestock, soil, roads, pastures, crops and wildlife is the major function of these plantings, though incidental wood production is a valuable by-product. Planted species are listed in Table 14.

TABLE 14

SHELTERBELT TREES

Green ash	Colorado blue spruce	Basswood
Cottonwood	Rocky Mountain juniper	Willow
Box elder	Siberian (Chinese) elm	Black Hills spruce
Hackberry	Dropmore (Manchu) elm	Ponderosa pine
American elm	Bur oak	Eastern red cedar
Scotch pine	Russian olive	

Source: Reference 50

Typical Shelterbelt

Shrubs

Shrubs are found in the forest understory, shelterbelts and urban environment. Urban shrubs have the least diversity. Species of the floodplain forest and those adjacent to water courses are adapted to moist soils. Berry shrubs are common in the Red River Valley and tributary streams: chokecherry, Juneberry, gooseberry, buckbrush, pin cherry, buffalo berry and hawthorne.

Shelterbelt species planted in the agricultural areas tend to be drought-resistant because they are not greatly affected by the drying influence of winds. Typical shelterbelt shrubs are compiled below in Table 15.

TABLE 15

SHELTERBELT SHRUBS

Aromatic sumac	Juneberry	Lilac
Sandcherry	Siberian crabapple	Nankin (Chinese) cherry
Wild plum	Dogwood	Willow
Chokecherry	Caragana	Cotoneaster
Honeysuckle	Buffalo berry	Potent illa
Russian olive	Golden currant	Highbush cranberry

Source: Reference 50

Urban shrubs provide little cover for wildlife and are valued primarily as food sources for birds and small mammals as well as for ornamentation. The species vary from lilac to evergreen, but species compilations are lacking.

Herbs

The Red River Valley lies within the prairie biome, and herbaceous plants are representative of those that grow in grasslands with light to moderate rainfall. Exceptions occur along wooded streams and lowlands. Annual rainfall, evaporation and soil moisture determine plant occurrence. On prairie remnants, water from rain and snow quickly drains

away, but as rain flows down small channels in the hillsides and valleys, more is absorbed. Flora in low areas are very sensitive to moisture fluctuations and occur only where precipitation is adequate throughout the growing season. The water of saltwater coulees is too saline for most plants. Roadsides and tracts maintained as prairie provide the "classic" wild flower habitat. Sedges and coarse grasses are found on wet meadows without an outlet for surface water. On gentle slopes at higher elevations a great variety of flowering plants occurs. A list of common herbaceous plants, by ecosystem, is given in Table 16. A list of uncommon herbaceous plants (rare in the study area) is given in Table 20.

TABLE 16

COMMON HERBACEOUS PLANTS

Flood Plain Forest

Nodding fescue	Wood nettle
Virginia wild rye	Wild ginger
Nodding muhly	Columbine
Charming sedge	Kidneyleaf buttercup
Sprengel's sedge	Tall meadowrue
Jack-in-the-pulpit	Bloodroot
Wild leek	Yellow wood violet
Large bellwort	Pink wood violet
False Solomon's seal	Wild sarsaparilla
Solomon's seal	Honeywort
Nodding trillium	Waterleaf
Carrion flower	Broad-leafed goldenrod
Blue cohosh	White snakeroot
Arrow-leafed aster	

Low Areas	**Salt Water Coulees**
Arrowhead	Saltgrass
Bladderpod	Wild barley
Pond lilies	Saltbrush
Violets	Red goosefoot
Asters	Pale goosefoot

Higher Elevations - Gentle Slopes

Lilies	Grass of parnassus
Spiderwort	Canada anemone
Camas	Closed gentian
Star grass	Hawksbeard
Blue violet	False dandelion

Rolling, Well-Drained Prairie

Pasque flower	Gaura
Torch flower	Gaillardia
Wild parsley	False mallow
Prairie violet	Western wallflower
Puccoon	Milk vetch
Tipsin	Prairie clover
Lead plant	
Tooth-leafed primrose	

Source: References 55, 59, 80, 81

FAUNA

Fauna of the Red River Valley can be divided into inhabitants of the grasslands and those of the woodlands. Many former animals of the grass prairie have vanished along with the loss of native prairies, and now are found only on remnant prairies, roadsides and shelterbelts. Woodland animals are common to the basswood-ash-elm forests bordering the Red, Red Lake and Turtle Rivers.

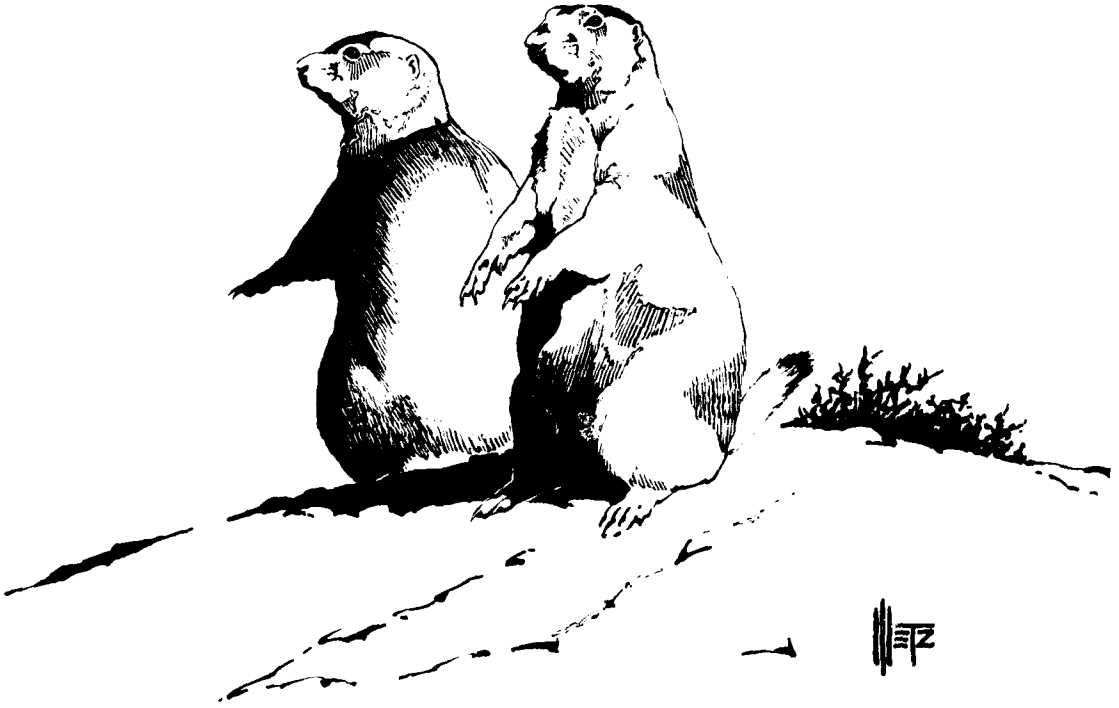
Mammals

White-tailed deer (Table 17) frequent the Red River bottoms, shelterbelts and brushy areas in stream valleys. They are no longer abundant because much habitat has been cleared and devoted to intensive c ulture. Surveys made in 1965 indicate that deer population densities in the area range from 15 to 20 animals per square mile. Moose infrequently migrate through the study region, but are not native to the area.

Mice, shrews and squirrels comprise most of the gnawing animals in the study area. Herbivorous species common to the timbered areas of the Red River are red squirrel, grey chipmunk, Franklin ground squirrel, groundhog, deer mouse, eastern meadow mouse and muskrat. Common grass species are prairie deer mouse, grasshopper mouse and meadow vole. All are important food resources for the red fox and hawks. The arctic shrew has been collected in marshy areas near Grand Forks, while the masked shrew and meadow jumping mouse are common to all habitats. The brown rat and house mouse are pests associated with urban areas. A former resident, the Canada beaver, occurs in greatly reduced numbers in the Red River and tributaries in the vicinity of Grand Forks.

Wooded portions of the Red River are the preferred habitat of the cottontail and snowshoe rabbits. Both are important prey of hawks, coyotes and red fox. The white-tailed jackrabbit is rarely seen in the study area, preferring habitat of the open prairies. The Grand Marais marshes, Kellys Slough and other wetland areas support furbearers, including muskrat, mink and beaver.

The red fox, raccoon and striped skunk are abundant in the study area, due to their ability to adapt to man's activities and manipulations of habitat. Shelterbelts and wooded areas are common haunts which provide food sources. Declining prairie chicken populations are further threatened by these predators. Shelterbelts also provide habitat for the Hayden masked shrew and the short-tailed shrew.



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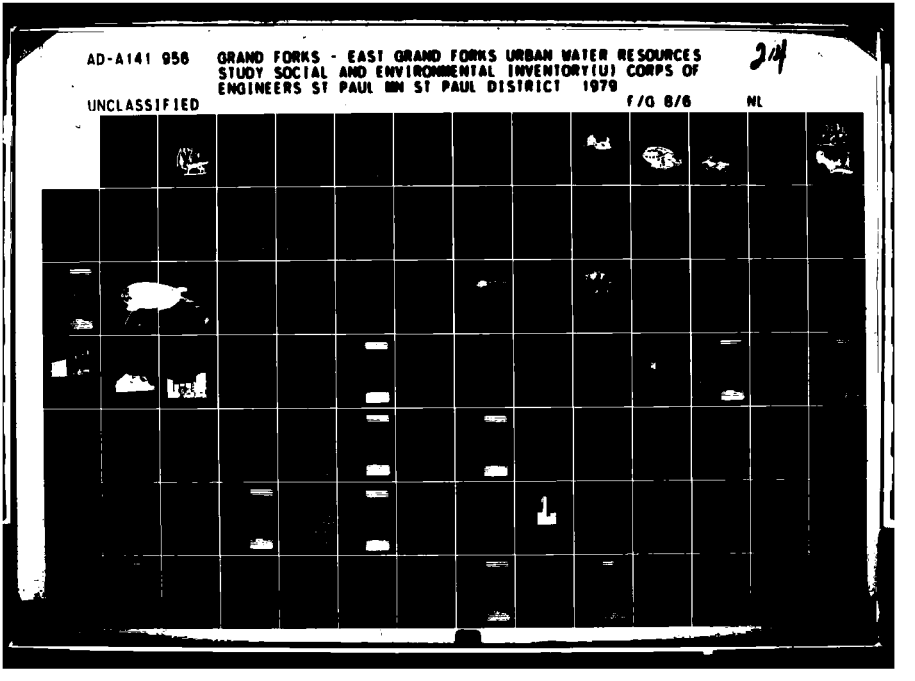

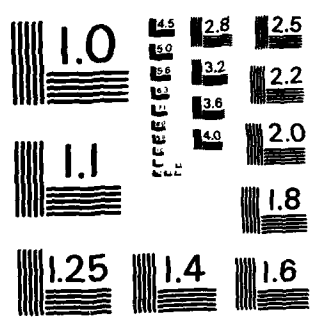

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The badger, coyote, black bear and other carnivores have not survived as well in the area. An early biological survey of the area in 1926 (Reference 55) noted several carnivores which then were rare, and probably are absent today due to habitat changes. The Canada lynx has disappeared and the kit fox is rarely seen. Bounties and poisoned bait in recent years have greatly reduced the number of coyotes in the area.

The hoary bat is found in heavy forest foliage. The large brown bat is common to all forested areas of North Dakota, whereas the little brown bat prefers to forage for insects near rivers. All are important as insectivores.

Fish

Information is limited on the fish species of the Grand Forks-East Grand Forks area, since there have been few fish surveys. In aquatic environments characterized by channelization, populations are dominated by the "hardy" species. Minnows and carp are the most widely distributed fish in the Red River tributaries of North Dakota, while redhorse, black

bullhead, burbot and freshwater drum are the hardy species of the Red River. Rock bass and crappie are the principal sport fish. Walleyed and northern pike are limited in the Red River, due to a lack of spawning habitat.

The Turtle River, during periods of adequate flow, supports populations of carp, catfish, walleye, sauger, northern pike and minnows. Walleye, carp and redhorse sucker are common species in the upper reaches of the Red Lake River, famous for its spring sucker fishery.

TABLE 17

LIST OF MAMMALS

Common Name	Abundant	Common	Infrequent or Occasional
Eastern chipmunk		X	
White-tailed deer		X	
Moose			X
Red squirrel	X		
Grey chipmunk		X	
Franklin ground squirrel		X	
Groundhog		X	
Deer mouse		X	
Eastern meadow mouse		X	
Muskrat		X	
Beaver		X	
Prairie deer mouse		X	
Grasshopper mouse		X	
Meadow vole		X	
Red fox	X		
Arctic shrew			X
Masked shrew	X		
Meadow jumping mouse	X		
Brown rat		X	
House mouse		X	
Striped skunk	X		
Raccoon	X		
Short tailed shrew		X	
Hoary bat		X	
Large brown bat		X	
Little brown bat		X	
Red-backed vole		X	

Source: Reference No.

Birds

Because of the fertile soils of the Agassiz Lake Plain (Figure 13), agricultural development has modified most of the arable acreage within the study region. The destruction of large tracts of natural habitat, and their replacement with croplands and other man-made landscapes, has left the Agassiz Lake Plain impoverished in its variety of birds (47 species), the least diverse of any region (Reference 61).

Seven different types of bird habitat are found in the study area. These include croplands, wetlands, tallgrass prairie, fencerows and roadsides, shelterbelts, floodplain forest and urban areas. The habitats and common species found in each are described in the following paragraphs. A list of common and secondary bird species by principal habitat type and frequency of occurrence is given in Table 18.

Typical cropland habitat within the Agassiz Lake Plain region encompasses sugar beet, potato, soybean and sunflower producing areas. Farming practices in the area include the tradition of summer fallowing every second or third year. Cover may include bare fallow fields, fields of sprout growth, fields of mature grain and stubble fields. Cropland species feed on weed seeds, insects, grasses and grains. The most common species is the horned lark. Others, including members of the plover family and longspurs, are listed in Table 18.

Wetland habitat is concentrated in Kellys Slough, Stewarts Slough, oxbows and lowlands. Cattails, bur reeds, arrowhead, rushes and grasses are the principal emergent vegetation, while pondweed, water lilies and duckweed are common aquatic plants. Kellys and Stewarts Sloughs are of major importance to waterfowl production in the intensively farmed Red River Valley. Land acquisition and management in Grand Forks County by the U.S. Fish and Wildlife Service provide nesting habitat for duck species and upland nesters. The most common wetland birds include the migratory ducks and geese, the marsh hawk and marsh wren, as listed in Table 18.

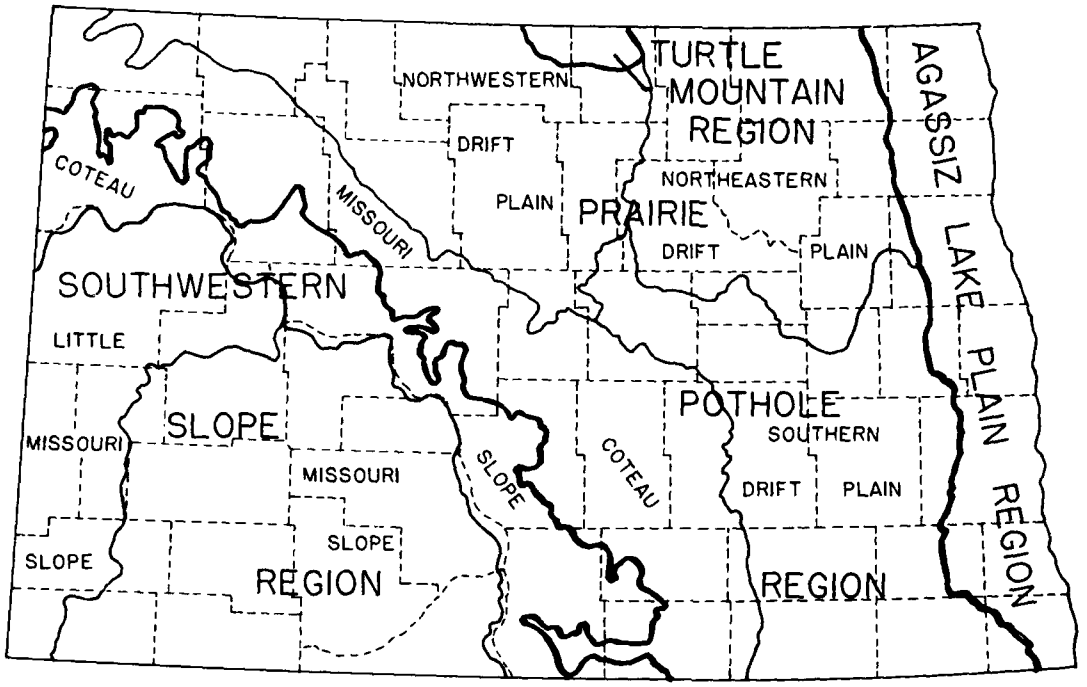


FIGURE 13

BIOTIC AREAS OF NORTH DAKOTA

SOURCE: REFERENCE NO. 61

The remaining native prairie grassland occupies less than one percent of the Agassiz Lake Plain. Dominant vegetation which provides cover and a food source for birds is composed of big bluestem, switch grass, Indian grass and prairie dropseed. Midgrasses are common, and include Kentucky bluegrass, little bluestem, slender wheatgrass, porcupine grass, mat muhly, fescue sedge and meadow sedge. Common and secondary bird species of the tallgrass prairie, including the plovers, western meadowlark, cowbird and bobolink, are listed in Table 18.

In the agricultural areas, narrow strips of uncultivated habitat occur along fencerows, section lines, roadsides and railroad rights-of-way. Vegetation at these locations is often composed of native prairie grasses and herbs, in combination with introduced weeds. Occasional native trees or shrubs are also present. Birds frequenting this type of habitat, such as the western meadowlark, lark bunting and sparrows, are listed in Table 18.

TABLE 18

COMMON AND SECONDARY BIRD SPECIES IN STUDY AREA

Species	Habitat Type and Frequency																			
	Croplands		Wetlands			Tall Grass Prairie		Fencerows & Roadsides		Shelterbelts		Floodplain Forest		Urbanized Areas	
	Common	Secondary	Summer	Migrant	Occasional	Common	Secondary	Common	Secondary	Common	Secondary	Common	Secondary	Common	Secondary
Horned lark	X														
Kildeer		X					X								
Upland plover		X				X									
Bobolink		X				X									
Western meadowlark		X				X		X							
Brown-headed cowbird		X					X	X			X		X		X
Lark bunting		X						X							
Savannah sparrow		X				X			X						
McCowan's longspur		X													
Chestnut-collared longspur		X													
Mallard			X												
Gadwall			X												
Pintail			X												
Green-winged teal			X												
Blue-Winged teal			X												
American widgeon			X												
Shoveler			X												
Wood duck			X												
Redhead			X												
Canvasback			X												
Ruddy duck			X												
Ring-Necked duck				X											
Lesser scaup				X											
Common goldeneye				X											
Bufflehead				X											
Blue goose				X											
Snow goose				X											
Canada goose				X											
Black duck					X										
Cinnamon teal					X										
Marsh hawk			X				X								
Greater prairie chicken							X								
Sharp-tailed grouse							X								
Short-eared owl							X								
Short-billed marsh wren			X				X								
Common yellow throat							X		X		X		X		
Red-winged blackbird							X		X						
Grasshopper sparrow							X								
LeConte's sparrow							X								
Vesper sparrow							X	X							
Clay-colored sparrow							X		X	X					
Gray partridge								X							
Eastern kingbird										X					X
Ring-necked pheasant									X						
Western kingbird									X	X				X	
Logger-Head shrike									X		X				
Dickcissel									X						
American goldfinch									X	X			X		X
Song sparrow									X	X			X		X
Swainson's hawk										X					
Red-tailed hawk										X		X			
Mourning dove										X			X	X	

TABLE 18

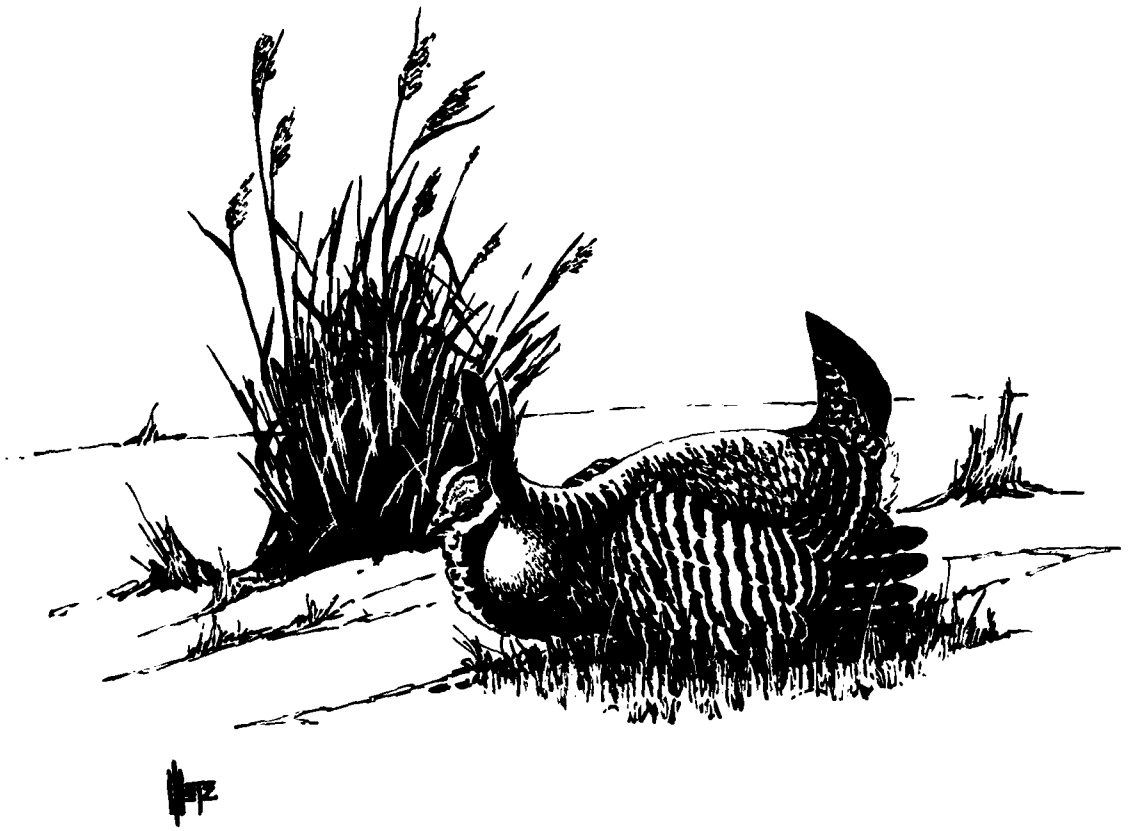
COMMON AND SECONDARY BIRD SPECIES IN STUDY AREA

Species	Habitat Type and Frequency																			
	Croplands			Wetlands		Tall Grass Prairie		Fencerows & Roadsides		Shelterbelts		Floodplain Forest		Urbanized Areas						
	Common	Secondary	Summer	Migrant	Occasional	Common	Secondary	Common	Secondary	Common	Secondary	Common	Secondary	Common	Secondary					
Great horned owl										X		X								
Willow flycatcher										X			X							
Common crow										X		X								
House wren										X		X		X						
Brown thrasher										X			X	X						
American robin										X		X		X						
Yellow warbler										X				X						
Common grackle										X				X						
American kestrel											X									
Black-billed cuckoo											X									
Long-eared owl											X									
Red-headed woodpecker											X		X							
Yellow-shafted flicker											X	X								
Least fly catcher											X									
Blue jay (local)											X	X								
Black-billed magpie											X									
Eastern bluebird											X		X							
Cedar waxwing											X		X							
Starling											X		X							
Warbling vireo											X	X								
Brewer's blackbird											X	X								
Baltimore oriole											X									
Orchard oriole											X									
Chipping sparrow											X			X						
Copper's hawk												X								
Downy woodpecker												X								
Hairy woodpecker												X								
Yellow-bellied sapsucker												X								
Great crested flycatcher												X								
Eastern wood pevee												X								
Black-capped chickadee												X								
White-breasted nuthatch												X								
Yellow-throated vireo												X								
Red-eyed vireo												X								
Yellow warbler												X								
American redstart												X								
Scarlet tanager												X								
Rose-breasted grosbeak												X								
Indigo bunting												X								
Sharp-shinned hawk													X							
Screech owl													X							
Barred owl													X							
Chimney swift													X							
Ruby-throated humming bird													X							
Gray catbird													X							
Veery													X							
Ovenbird													X							
Purple martin (local)														X						
House sparrow														X						
Common nighthawk															X					
Rock dove															X					

The long narrow strips of shelterbelt trees and shrubs designed to protect farms from severe winter winds and improve soil moisture conditions also support the second widest variety of bird life. A variety of native and exotic trees and shrubs is characteristic of these plantings and provides adequate food supply and shelter. The diverse fauna, including hawks and owls, reflecting an abundance of small mammal prey in this habitat, and various songbirds, are listed in Table 18.

The floodplain forest community along the Red River, the Red Lake River and other smaller tributaries supports the widest diversity of bird populations in the area. Mature trees and a usually well-developed understory composed of small trees and tall shrubs provide cover and ample food supply. The herbaceous vegetation of the forest floor is especially luxuriant and is composed of a great variety of seed species supportive to bird life. The most common birds found in these areas, including numerous songbirds, great-horned owl and woodpeckers, are also listed in Table 18.

Bird species found in urban areas are somewhat less diverse than those of the shelterbelts and floodplain forest. These species have adapted to man's activities and find habitat niches in office buildings, stores and other commercial buildings, homes and apartment buildings, garages and sheds, lawns, parks and golf courses with ornamental trees and shrubs, garden plots and streets and driveways. Common and secondary species found in these areas are listed in Table 18.

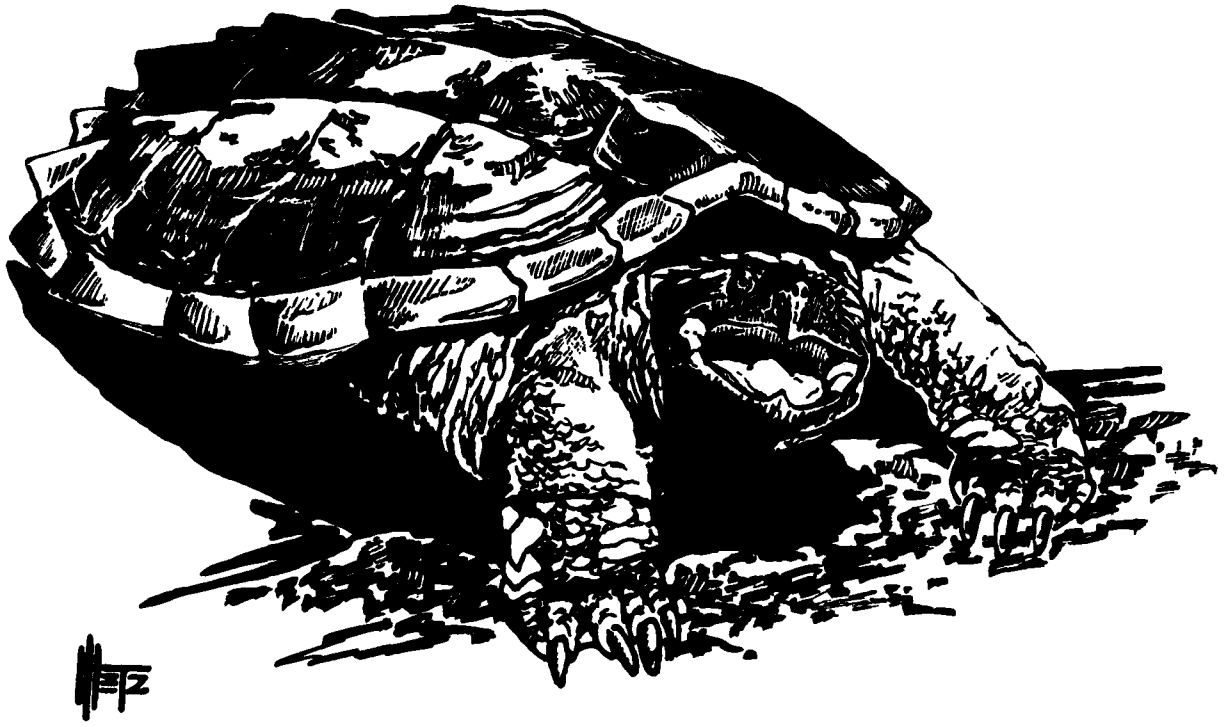


Reptiles

There are three common reptiles in the Grand Forks area: the snapping turtle, painted turtle, and western plains garter snake.

The snapping turtle is common throughout North Dakota and is found in sluggish streams, ponds and lakes - most notably in oxbows of the Red River of the North. The western painted turtle is common to the study area and prefers warm shallow water areas with some plant growth.

A frequent discovery in stream margins, sloughs and lakes is the plains garter snake. This reptile is also common in open lots and parks of the urban area.



Amphibians

Amphibians found in the study area include salamanders, toads and frogs. Tiger salamanders and mud puppies are present in the study area, usually near water.

Toad habitat includes grassland near streams and drainage ditches. The American toad is rare to Grand Forks County, most often being found in southeastern North Dakota. The great plains toad and the Dakota toad are common throughout the state.

The leopard frog, common in the study area, resides in or near almost every still or flowing body of water. Also found in the area are the chorus frog and wood frog.

THREATENED OR ENDANGERED SPECIES

Several species of fauna known to be presen[illegible]eviously have disappeared from the area. These include the bison, elk, grizzly bear, p[illegible]rn antelope, trumpeter swan and passenger pigeon. Although considerable research is [illegible]ntinuing, the status of many species is either uncertain or unknown at this time. A list of mammal species considered threatened, endangered, or otherwise of special interest, is given in Table 19. The special interest species classification is recognized by local and State researchers because of restricted distribution, numbers, aesthetic appeal or past history of near extinction.

The only bird considered endangered nationally which may infrequently visit the study area is the American peregrine falcon. However, no information on any sightings in the study area was found. The greater prairie chicken is considered threatened in the regional area, due to rapidly declining numbers caused by loss of permanent grasslands for nesting and loss of food supply due to intensive agriculture. The western burrowing owl and ferruginous hawk, both common in other parts of North Dakota, are rarely sighted in the Lake Agassiz region. A list of birds considered threatened or of special interest because of unusual or unique values or vulnerability of habitat is also given in Table 19.

Only two species of amphibians, the mud puppy and gray tree frog, are of concern because of their limited numbers. One fish species, the banded killifish, is found only in Kellys Slough in Grand Forks County, and is listed as being of special interest due to its limited distribution.

A list of endangered flora in the study area is given in Table 20.

TABLE 19

LIST OF THREATENED OR ENDANGERED FAUNA

Common Name	Scientific Name	Category	Distribution
Mammals			
Fisher	Martes pennanti	Status Undetermined	Streams and woodlands in northeastern North Dakota
Water shrew	Sorex palustris	Special Interest	Eastern Red River Valley
Eastern mole	Scalopus aquaticus	Special Interest	Possibly in Red River Valley One known record.
Bobcat	Lynx rufus	Special Interest	Generally in the Badlands and along the Canadian border and lower Red River; however, sightings have been reported along most river systems.
Birds			
Greater prairie chicken	Tympanuchus cupido pinnatus	Threatened	Prairie Chicken Management Area in Grand Forks County
Western burrowing owl	Athene cunicularia	Status Undetermined	Rare in Lake Agassiz Region
Ferruginous hawk	Buteo regalis	Status Undetermined	Rare in study area
Bald eagle	Haliaeetus Leucocephalus	Special Interest	Formerly found along the Red River, Missouri River and Devils Lake
Common Goldeneye	Bucephala clangula	Special Interest	Breeds only in Turtle Mountains; migrates over rest of state
Pileated woodpecker	Dryocopus pilcatus	Special Interest	Along the Red River and its tributaries
Amphibians and Reptiles			
Mud puppy	Nocturus maculosus	Special Interest	One record - at Grand Forks
Gray tree frog	Hyla versicolor	Special Interest	Red River Valley
Fish			
Banded killifish	Fundulus diaphanus	Special Interest	Kellys Slough in Grand Forks County

Source: References 49, 76, 78

TABLE 20

THREATENED OR ENDANGERED FLORA

Common Name	Scientific Name	Category	Distribution
Sedge	Carex prarisa Dewey	Unique	Wet meadows and boggy areas
Dwarf spikesedge	Eleocharis parvula (R. & S.) Link	Rare in Grand Forks County	Wet sands along lakes
Yellow monkeyflower	Mimulus guttatus D.C.	Rare in study area	Moist soil along streams and lakes

Source: (Barker, Larson & Williams, NDSU, 1976)

ECOSYSTEM TRENDS

The original tallgrass prairie is essentially gone from the Grand Forks-East Grand Forks area. Remaining stands of native bluestem, switch grass, Indian grass and wild rye are confined to purchased prairie remnants, fencerows, roadsides and shelterbelts. Prairie wild flowers exist solely within these habitats. Elk and buffalo were eliminated by hunting pressure and stand in small protected herds as relics of the past. Prairie chickens exist as threatened species in protected areas (U.S. Fish and Wildlife Service 1973 "Redbook" designation, not on Federal Threatened or Endangered Species list).

Major ecosystem changes commenced in the 1800's with the arrival of the white settlers. Clearing, cultivating and pasturing altered the native flora and fauna. The high fertility of the soils, attributable to the accretion of tallgrass debris, has led to modification of nearly all arable acreage. Principal crops now grown are small grains, corn, potatoes, sugar beets, soybeans and sunflowers. These crops provide sterile monotypic habitats which have greatly reduced the former diversity of prairie fauna and flora, as illustrated by the relatively small variety of birds in the Agassiz Lake Plain region.

The breaking of the prairie sod had other "ripple effects." Lack of surface vegetation promoted loss of soil moisture. Early farming practices accelerated soil erosion, culminating in the Dust Bowl of the 1930's. Over the years, soil erosion has contributed to the sedimentation of the Red River and its tributaries. Shelterbelts were planted after the Dust Bowl period to protect farmsteads from wind and to promote snow accumulation, both functions formerly served by the original 6-foot big bluestem.

With fencing and shelterbelts, species are now associated with the habitat of the "edges," where two or more habitats are in proximity. Some of the original creatures of the open prairie have disappeared. The red fox, striped skunk, coyote, hawks, small mammals and birds capable of foraging in different habitats now dominate shelterbelts and fencerows.

Forested areas in the study region have never been widespread and are located on the Red River floodplain and adjacent to tributaries. Floodplain forest is especially important because of its small acreage and mature native stands of bur oak, hackberry, American elm, basswood and green ash. Many wildlife species, especially white-tailed deer, reside in the heavy cover of these forest corridors. Thus, although timber acreage in shelterbelts and windbreaks is increasing due to State and Federal planting programs, native timber is decreasing due to agricultural clearing operatings and urban growth. Native tree species are important because of their longevity and now relatively infrequent occurrence.

Aquatic ecosystems have undergone many changes. Wetlands which harbored great numbers of waterfowl in the 1800's have been reduced to oxbows, farm ponds and remnants owned by State and Federal game management agencies. Wetlands were ill-suited to cropping and thus were drained. Temporary wetlands were drained first and, as farming costs and agricultural commodity prices increased, permanent wetlands followed. These areas have great value for waterfowl breeding, spawning, groundwater recharge and nutrient inactivation. Current threats to wetlands come from sedimentation, channelization and land use changes.

The Red River of the North and tributary streams have heavy silt loads resulting from intensive cultivation and bank erosion. Elevated turbidities and sedimentation dictate species tolerant of such conditions: fathead minnows, common white sucker, black bullhead and carp. Industrial pollution is generally not a serious factor in species distribution in Red River tributaries. However, potato and sugar beet processing plants which release effluents into the lower portions of the streams during part of the year impact on aquatic habitat. Minimally treated sewage discharges from small towns along tributary streams is of more consequence (Reference 56) than the processing plant discharges.

Saline ecosystems provide habitat for the banded killifish, which prefers clear, saline water with abundant vegetation. This species is localized specifically in Kellys Slough. Other unique ecosystems occur in the saltwater coulees where salt grass, wild barley, saltbush and red and pale goosefoot may be present.

The original vegetation and topography of the urban portion of the study area have been replaced by buildings, landscaped lawns, parks and golf courses, ornamental trees and shrubs, streets and driveways. Native plant and wildlife species have retreated to rural areas and the Red River floodplain forest. Greatest threats are posed by clearing trees and shrubs of the floodplain forest for urban development. Air pollution, water pollution and solid waste disposal are problems common to any metropolitan area. However, a serious problem in the urban study area is the effect and rate of change from development of "marginal areas" which foster wildlife and include native stands of timber. Because of the dominance of agriculture in the study region, what little native forest there is remains adjacent to the Red River corridor in Grand Forks-East Grand Forks.

Intensive agriculture will continue in the fertile soils of the study region to keep pace with an increasing demand for agricultural food products. There are continuing demands for clearing forested areas and draining remaining wetlands for crop production. High commodity prices render such undertakings more economically feasible now than in the past.

With changing land use, native prairie tracts and sensitive species are subject to development forces. Habitat changes are largely irreversible. Buffalo and elk will likely never return. The Prairie Chicken Management Area flock is precariously unstable, possibly declining. Such species have unique niche requirements and cannot adapt; species which can adapt - skunk, raccoon, fox and coyote - maintain stable populations in the area.

Public Law 92-500, the Federal Water Pollution Control Act Amendments, is directed at abating point sources of pollution. Funds are available to municipalities for upgrading their sewage treatment plants, and industries are required to meet stringent effluent requirements by 1977. Thus, the threat of municipal and industrial water pollution should diminish. Nonpoint sources of pollution - sediment, nutrients, and pesticides - will continue to impact on the Red River and its tributaries, at least for the near future.

SUSCEPTIBILITY OF FAUNA TO URBANIZATION

The river forest corridor is the natural system most susceptible to urbanization because it has been changed the least. Most of the larger fauna in the region are associated with this system, either exclusively or on an edge basis with the other systems. Extensive alteration of the river woodland system would seriously impact the total natural environment of the region.

The aquatic system is nearly as sensitive as the forests to human activity and urbanization. It is the only natural system which, because of periodic flooding, causes large scale damage to the human environment, and therefore invites control and modification. This same dynamic character has made the rivers, streams and lakes of the aquatic system the depository of urban wastes. These factors combine to make the aquatic system the natural system subject to the greatest degree of human concern.

Open land generally is the natural system least susceptible to change because it has already been changed by extensive farming practices.

The following paragraphs discuss the susceptibility and sensitivity of a selected list of species to the modification of their habitat by urbanization.

Carp (Cyprinus carpio)

The carp, considered a rough fish in the United States, was introduced from Europe by settlers who planned to culture it in ponds. In the Red River, the carp is one of the most abundant fish. It survives in water of poor quality and would be affected only by intense urbanization and severe water quality problems.

Black bullhead (Ictalurus melas)

The black bullhead is considered a rough fish in the region. It is most common in the pools of streams with mud bottoms and in lakes and ponds. This species is tolerant of high turbidity and would not be as vulnerable to urbanization as other catfish.

Red Fox (Vulpes Fluva)

The red fox subsists primarily on rabbits and mice and lives along the forest borderlands and open fields. Damage to woodlands and woodland-openland edges would harm the habitat of this species.

Coyote (Canis Latrans)

Studies have shown that the coyote maintains relatively stable populations in the study area. The coyote generally prefers brushy country along the edge of timber in open farmlands, where rabbit and small rodent populations are highest. Rabbits constitute from one-half to two-thirds of the coyote's diet, with the remainder made up of mice, carrion and small amounts of other foods. The coyote has generally adapted to agricultural activities. It can adapt to very low density urban activity. As urbanization becomes more intense, the population drops quickly.

Short-tailed shrew (Blarina brevicauda)

The short-tailed shrew is found throughout the study area in woody, brushy areas and, less frequently, in a grassland habitat. Populations may range from one to four per acre, with frequent fluctuations causing peaks as high as 25 per acre. The short-tailed shrew is basically insectivorous in its food habits. Clearing windbreaks, woodlands and other brushy areas for increased cultivation or construction eliminates the habitat of this species. It is, therefore, harmed by both urbanization and more intense agricultural practices.

Tiger salamander (Ambystoma tigrinum)

The tiger salamander adults live under debris near water and in burrows of crayfish and mammals. They breed in ponds and temporary water. The larvae are strictly aquatic and eat small aquatic organisms. Trash and other debris from urbanization may increase the habitat of this species. Only with the most dense development would it be adversely affected.

Eastern gray tree frog (Hyla versicolor)

The common tree frog is restricted to wooded bodies of water such as streams, ponds and swamps. Except during the breeding season, it lives in trees. Urban development which removes or alters riparian habitat would adversely affect this species.

Bullfrog (Rana catesbeiana)

The bullfrog occurs in very limited numbers in most tributaries, ponds and lakes of the region. It is restricted to permanent water. Urbanization which would degrade water quality or eliminate water edge vegetation would harm the bullfrog.

Common snapping turtle (Chalydra serpentina)

The common snapping turtle is well adapted to permanent water. It is a bottom dweller and a poor swimmer, and may grow to a weight of 50 pounds. Urbanization which eliminates ponds or pollutes streams would adversely affect this species.

Eastern meadowlark (Sturnella magna)

This bird, a common resident of the region, prefers open areas with dense grass. Urban development which occurs in this habitat would displace this species.

Great blue heron (Ardea herodias)

The great blue heron is common in the marshes, rivers and streams of the study area. Human activity disturbs this bird. Urban development can, therefore, harm this species by removing its habitat and by increasing human activity around its habitat.

Great horned owl (Bubo virginianus)

The great horned owl is a common resident of the woods and woodland-openland edges of the Red River and Red Lake River corridors. Urbanization can harm this bird by removing or altering the forest habitat.

Nighthawk (Chordeiles minor)

The nighthawk often nests on rooftops and feeds in developed areas where insects are attracted to lights. In urbanized areas which allow nesting, this bird seems to adapt well. Urbanization, therefore, may not be of particular harm to this species and may actually provide it with a habitat.

Franklin ground squirrel (Citellus franklinii)

The Franklin ground squirrel prefers a prairie type habitat bordered by woods. Insects comprise a major portion of its diet, with grasshoppers and beetles the main types. The Franklin ground squirrel is listed as common in the wooded Red River corridor. The woodland border habitat of the squirrel is susceptible to agricultural pressure and urbanization.

Woodchuck (Marmota Monax)

Woodchucks are found in greatest numbers along gullies and creek banks in the study area. The primary foods of the woodchuck are wild lettuce, white clover, red clover and grasses. Woodchuck densities range from one per 11.5 acres to one per 36 acres. The woodchuck is listed as common in the wooded areas. Urban development of any density which replaces the cropland-woodland edge would eliminate the woodchuck's habitat.

White-tailed deer (Odocoileus virginianus)

The white-tailed deer inhabits river bottoms, brushland and grassland areas. It feeds primarily on grasses, domestic crops and browse such as leaves, twigs and the fruits of trees and shrubs. It has adapted well to agricultural activity. However, it is sensitive to human activity and would be disturbed by even low density urbanization.

Eastern cottontail rabbit (Sytvilagus flordanus)

The cottontail rabbit is highly adaptable to almost all types of cover, but prefers brushy areas and briar patches. It is a prolific species, having a wide distribution but restricted in its home range. Five to ten acres is the general size of a cottontail's home range; however, some may range up to 22.5 acres during breeding periods. The cottontail is a complete vegetarian, with herbaceous plants comprising the bulk of the diet in summer and fall months, and woody plants being taken during snow cover. The cotton tail can adapt well to low density urban development where suitable habitat is left or where ornamental vegetation is established. Intense urban development would eliminate its habitat and displace the species from the developed area.

Mink (Mustela vison)

One basic requirement for mink habitat is permanent water, preferably with a stand of timber close by. The mink's diet includes crayfish, fish, mice, rats, birds and rabbits. Human activity within the region's riparian forest would reduce the mink's habitat. Overgrazing of the stream edge by livestock would also harm this species.

Striped skunk (Mephitis mephitis)

The striped skunk favors open prairie regions with brush field borders and fencerows. The species is omnivorous, with animal matter predominating; e.g., insects, mice, small reptiles, frogs, salamanders and bird eggs. Population density of the striped skunk is approximately two per 100 acres. The habitat of this species is reduced when windbreaks or other brushy edges are removed.

Beaver (Castor canadensis)

The beaver inhabits streams, rivers, marshes and small lakes throughout North Dakota and Minnesota. Principal foods of the beaver include the bark of poplars, cottonwood and willow. In areas where it is available, corn is readily taken as food and also as building material for its dams. The beaver is considered to be increasing in areas where appropriate habitat is available. However, urbanization and agricultural practices which eliminate woodlands along streams would harm this species.

Muskrat (*Ondatra zibethicus*)

The muskrat is fairly common along rivers in both North Dakota and Minnesota. It inhabits ponds, lakes and streams in areas where the water is either still or slowly flowing. A pair of muskrats has one litter per year with an average litter size of six. The maximum breeding concentration for muskrats is about two pairs per acre. Removal of aquatic habitat would result in reduced numbers of this species.

Raccoon (*Procyan lotor*)

The raccoon is common throughout forest bottomlands in the area. Proximity to water seems to be a major factor in the selection of a homesite for the species. Raccoons eat both plant and animal matter; e.g., cherries, corn, nuts, crayfish, grubs, frogs and even bats. Population estimates range from approximately one per acre in an excellent habitat to one per 2 acres in a good habitat. It can adapt to low density urbanization if adequate habitat is retained.

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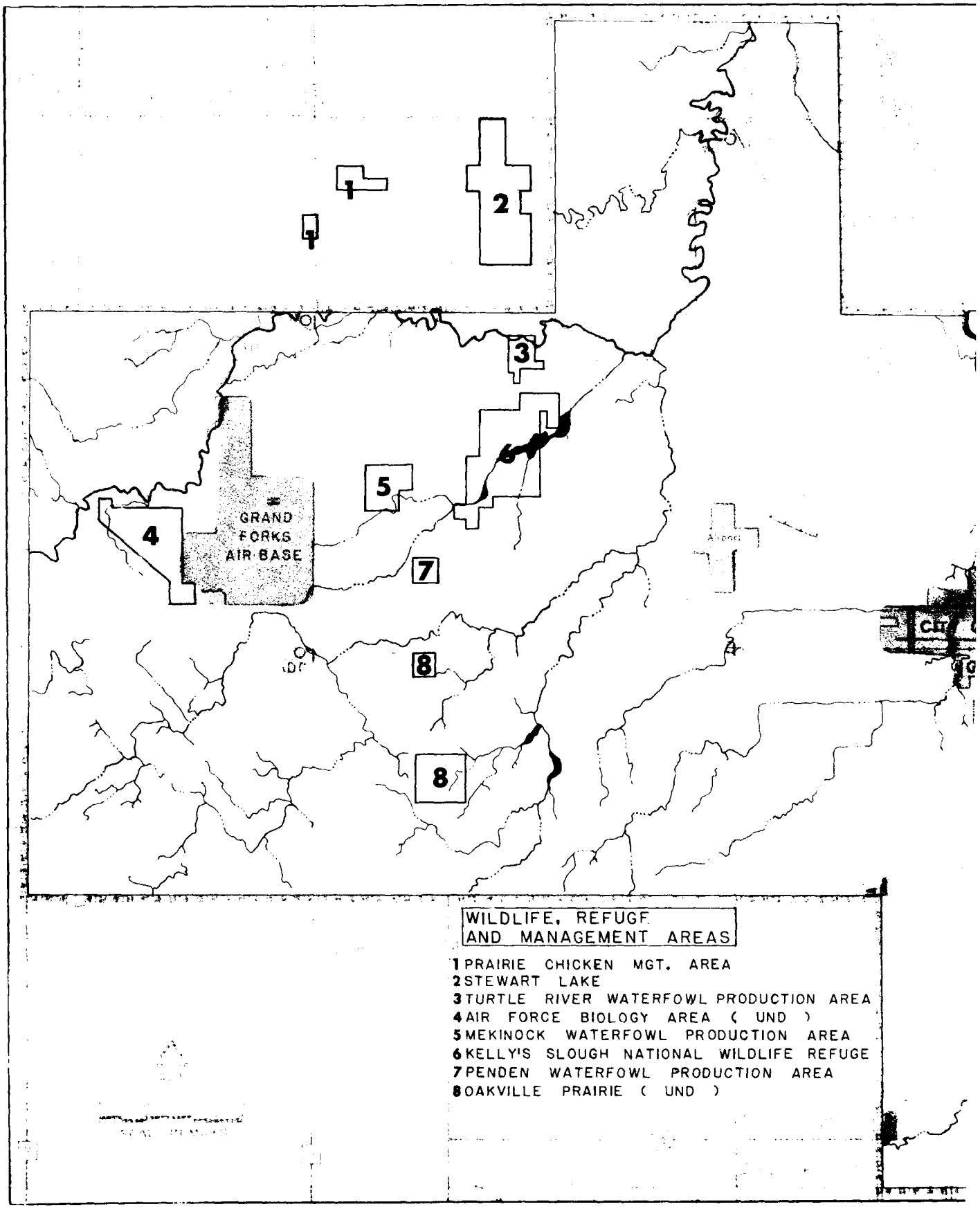
1
2
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GRAND FORKS AIR BASE
5
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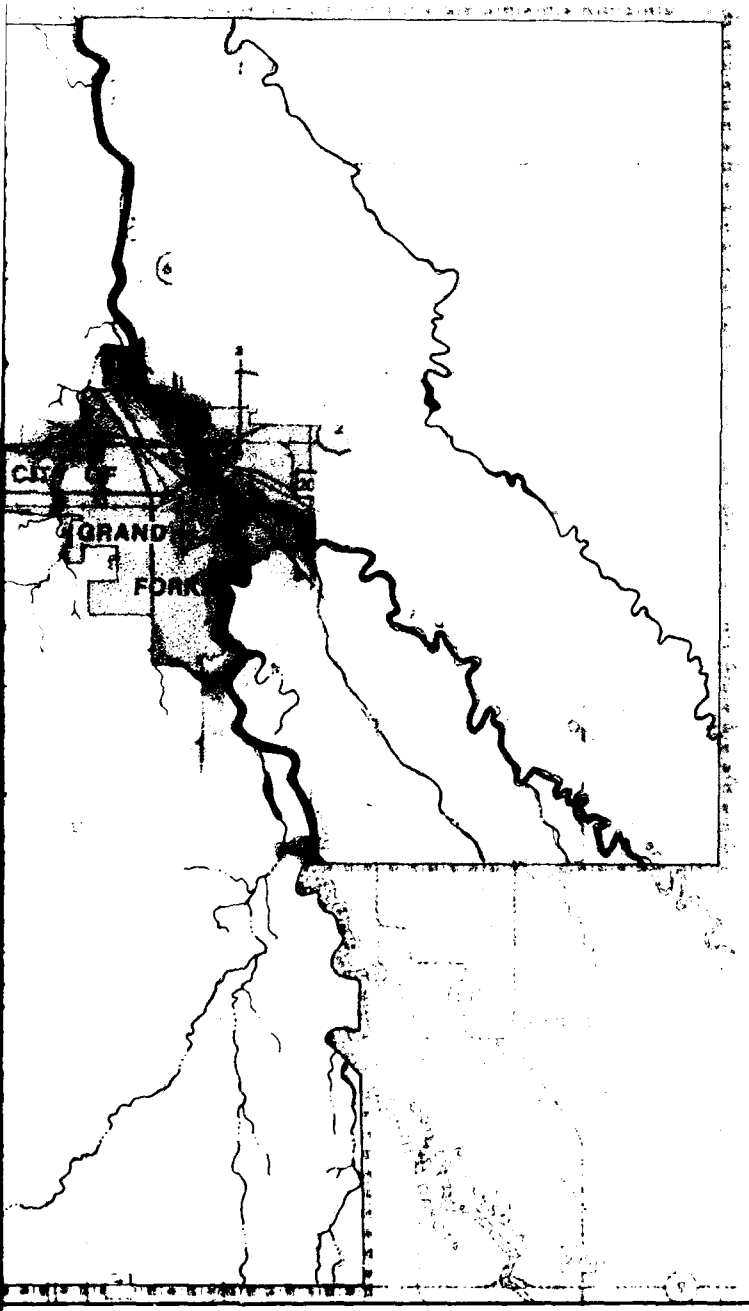
8
WILDLIFE, REFUGE AND MANAGEMENT AREAS
1 PRAIRIE CHICKEN MGT. AREA
2 STEWART LAKE
3 TURTLE RIVER WATERFOWL PRODUCTION AREA
4 AIR FORCE BIOLOGY AREA (UND)
5 MEKINOCK WATERFOWL PRODUCTION AREA
6 KELLY'S SLOUGH NATIONAL WILDLIFE REFUGE
7 PENDEN WATERFOWL PRODUCTION AREA
8 OAKVILLE PRAIRIE (UND)

Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



URBANIZED AREAS

WOODLANDS

FLOOD PLAINS

OPENLANDS AND CROPLANDS (uncultivated)

LAKES AND PONDS

MAJOR RIVER SYSTEM

SECONDARY OR INTERMITTENT STREAMS

6 WILDLIFE, REFUGE OR MANAGEMENT AREAS

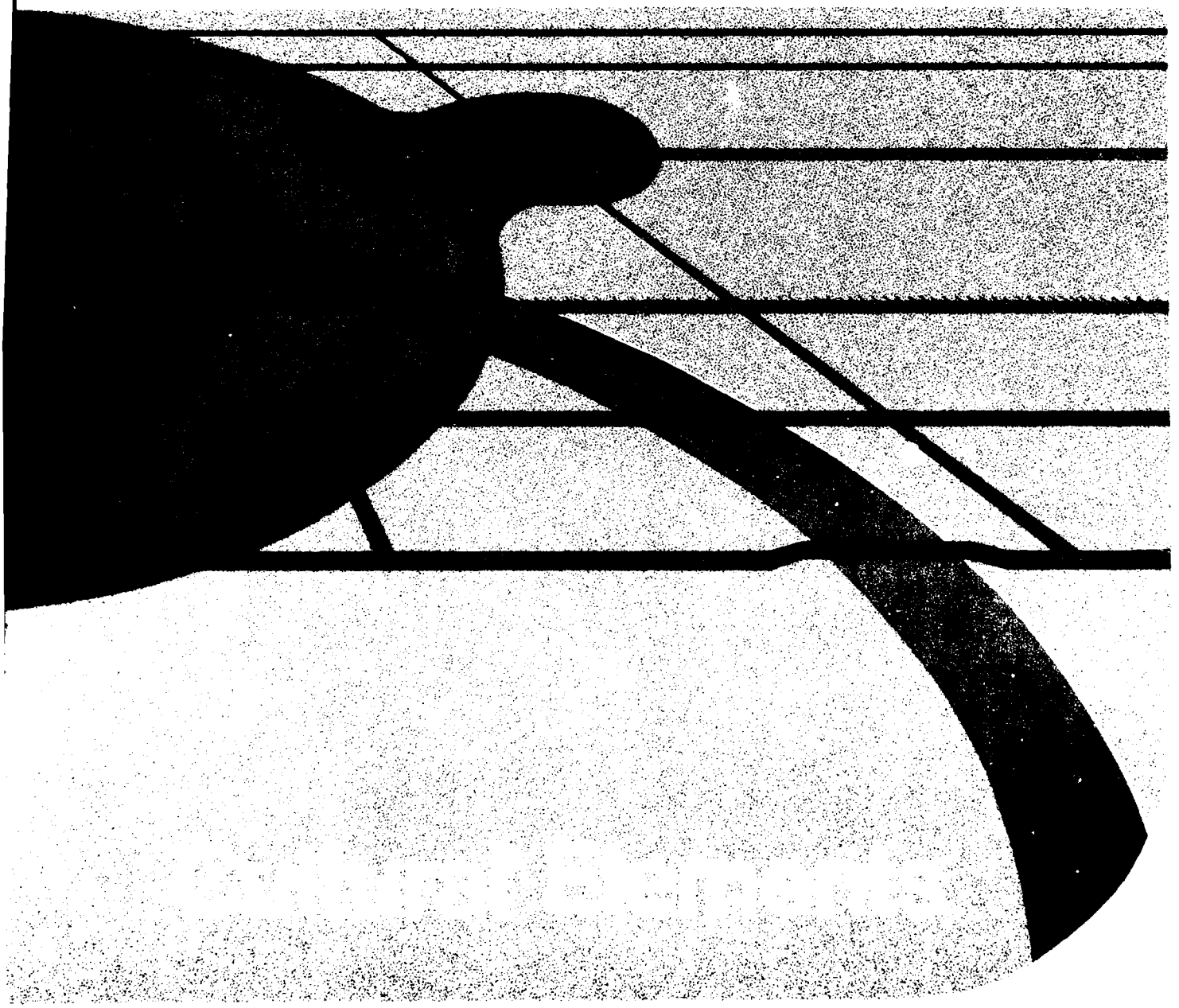
NOTE: SEE TABLES 16-20 FOR DISCRIPTION OF FLORA AND FAUNA IN EACH AREA.

SOURCE: REFERENCES 48,60,73,76.

PLATE 6

Grand Forks
East Grand Forks

URBAN WATER RESOURCES STUDY



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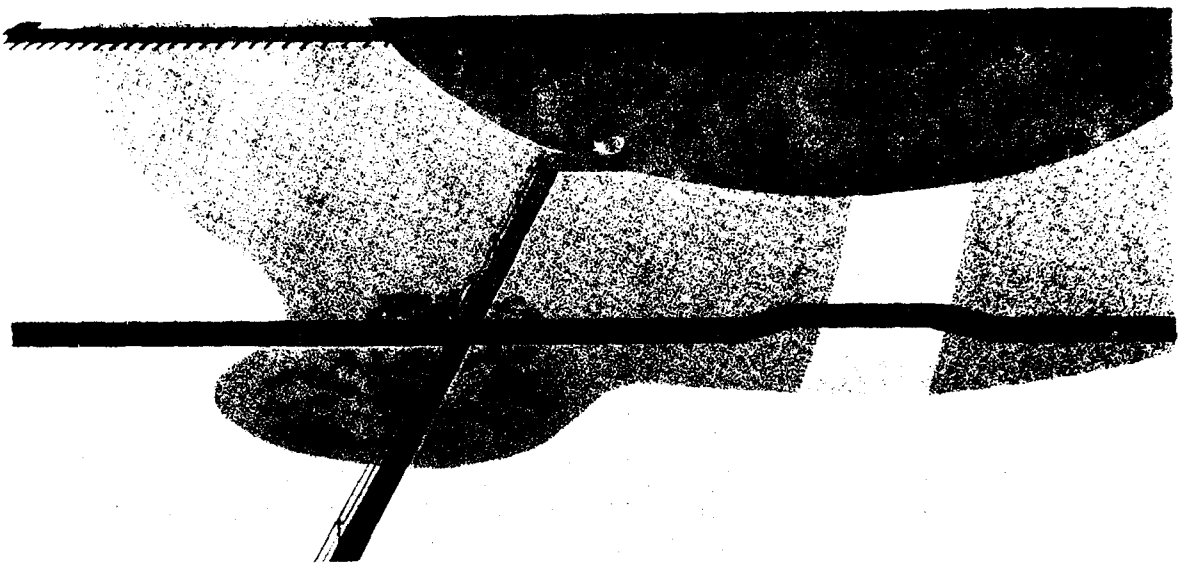


CULTURAL ELEMENTS

Introduction

Archeological and Historical Resources

- Introduction
- Prehistoric
- Historic

Social Organization

- Introduction
- Demography
- Geographic Distribution
- Governmental Organization
- Economy
- Occupational Structure
- Education
- Social Support Services

INTRODUCTION

The social and cultural characteristics of the study area include the material, behavioral and organizational attributes of past and present human inhabitants. These characteristics are divided into two components: those related to past occupations by prehistoric American Indians and historic groups of Indians, traders and settlers; and those related to the populations which currently reside in the area.

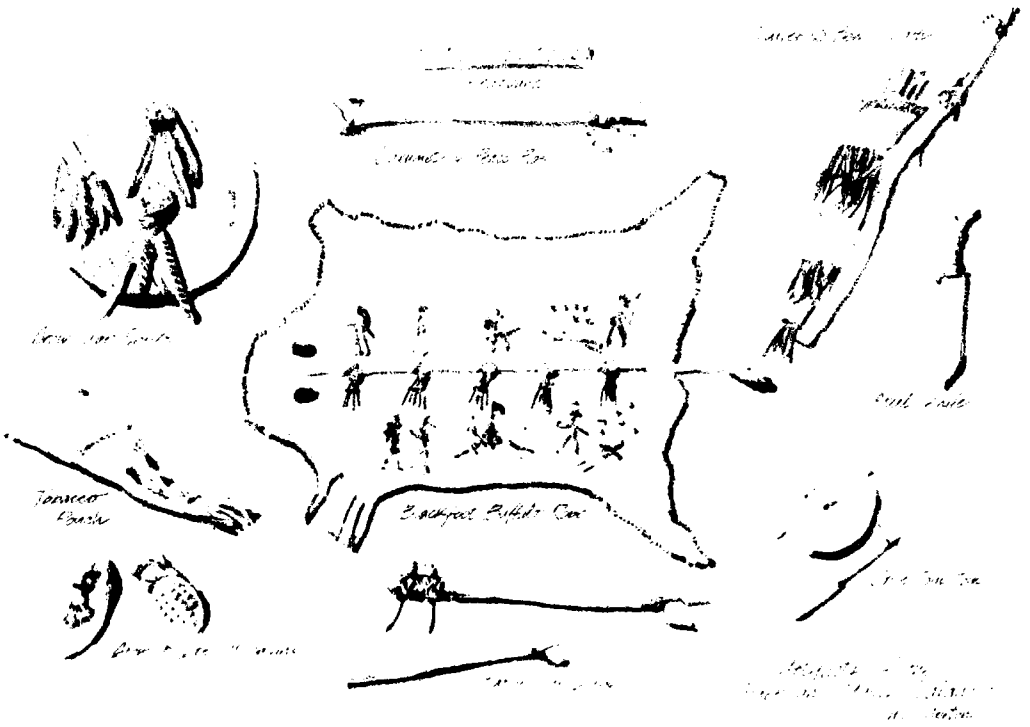
The information on archeology and history is presented first. That section is followed by one on social organization, which discusses the major institutional sectors of contemporary society with an indication of their functions and resource bases. The characteristics of the present population are presented as components of the functioning system of human interaction in the study area. Taken together, the historical and contemporary materials make up a dynamic progression of the past and present, combining the experiences and characteristics of the many groups of people who have lived in the area we now know as Grand Forks-East Grand Forks.

ARCHEOLOGICAL AND HISTORICAL RESOURCES

Introduction

Archeological sites and historical structures constitute the cultural resources of the study area. The archeological sites of prehistoric occupations contain all the information we will ever have about human life during those times. Cultural resources are scarce, irreplaceable and have intrinsic, individual value. When the locations of significant sites and structures are known, their worth can be evaluated and taken into account when various development alternatives are being considered.

Though the available information is limited, we know the general dimensions of prehistoric and historic life in the study area. The following sections provide a glimpse of the history of the area and a sense of what remains to be learned. With this awareness, those making decisions about the future of the Grand Forks-East Grand Forks area should be better able to contribute to the protection and enhancement of the cultural resources of the past.



Pre-historic

The archeological data in the Grand Forks-East Grand Forks area are very incomplete, but there is sufficient information to establish that early man inhabited the area about 8,000 years ago. Human occupation of the Red River Valley dates back to the "Early Man" period and extends through several definite time periods, as evidenced by changes in weapons and hunting and farming practices.

The earliest valley inhabitants occupied the area from about 8000 to 5500 B.C. These people were small roving bands of bison hunters who used spears or the atlatl and dart (throwing stick). One known site of this early occupation exists in the valley, but none are known in the study area.

Immediately following this early occupation is a period of about 2,500 years during which the early hunters left the valley. It has been surmised that a severe drought occurred and deserts formed. Following the drought came the middle prehistoric period of 3000 to 1200 B.C. During this period, the people, also bison hunters, likely followed the reforestation onto the now dry glacial lake bed. There is also reason to believe that the "Old Copper Culture" from the upper Michigan and northern Wisconsin regions was introduced in the area during this period.

Following the second period of occupation is a 700-year period from 1200 to 500 B.C. for which no archeological evidence of human occupancy exists. This does not suggest a total evacuation of early inhabitants, but is more probably due to a lack of field research in the area.

There is again limited archeological evidence of human activity in the Red River Valley during the period 500 B.C. to 500 A.D. During this period, the people were also bison hunters. However, signs of increased diversification in ways of making a living, such as primitive forms of agriculture, are evident. During a later phase of this prehistoric occupation of the valley (200 to 1600 A.D.), a rapid increase in the development of technology occurred; primitive tools and implements, increased use of the bow and arrow in hunting and warfare, and greater reliance on agriculture developed.

One known archeological mound site indicating evidence of prehistoric occupation is present in Huntsville Township, Polk County, Minnesota. This site has not been excavated to date. Other known mounds or mound groupings are present at six locations in the Grand Forks County study area. These mounds are also unexcavated, primarily due to a lack of funding for needed surveys. Any future federally supported water resource programs would necessarily include provisions for surveys of known or presently unknown historic and archeological resources that may be impacted on by proposed projects.

Historic

The early seventeenth century saw the first emergence in the area of European explorers and traders, as evidenced by metal arrowheads, flints and other artifacts found. Closely following these early explorers came an influx of white fur traders to the Red River and tributaries. Known Indian groups in the area during early historic times were the Bungi, Hidatsa and Dakota. Later groups included the Dakota Sioux and Assiniboine, in the forested portion of the Red River Valley in Minnesota, and the Algonquian tribes in the western portions of the valley.

The first white explorer in the area was most probably the French explorer Verendrye, in about 1738, followed somewhat later by the geographer David Thompson. France initially claimed the area in 1671, with subsequent competing claims by England for all the Hudson Bay Company lands draining to Hudson Bay. The United States gained possession of the area in 1803 as part of the Louisiana Purchase from France.

The Grand Forks-East Grand Forks area was a Red River base for early French settlers, who established a trading post at the junction or fork of the Red and Red Lake Rivers and called it "L' Grande Fourche," from which Grand Forks is derived. From this time on, a steady influx of traders, trappers and adventurers moved into the area. A large influx of colonists, known as "Lord Selkirk's Colonists," moved into the area in the early 1800's.

Three principal oxcart or travel routes were used in the area during this early period of white settlement. The Pembina and Fort Garry to St. Paul trail likely commenced in the early 1840's and traversed the east bank area of the river valley. The old Georgetown trail opened in about 1859 and traversed the western part of the present Grand Forks County. The Goose River trail from Caledonia to St. Joseph and Fort Garry passed through the central part of the county. The "Lone Tree," in Section 21 of Blooming Township, served as a landmark to early travelers on this trail.

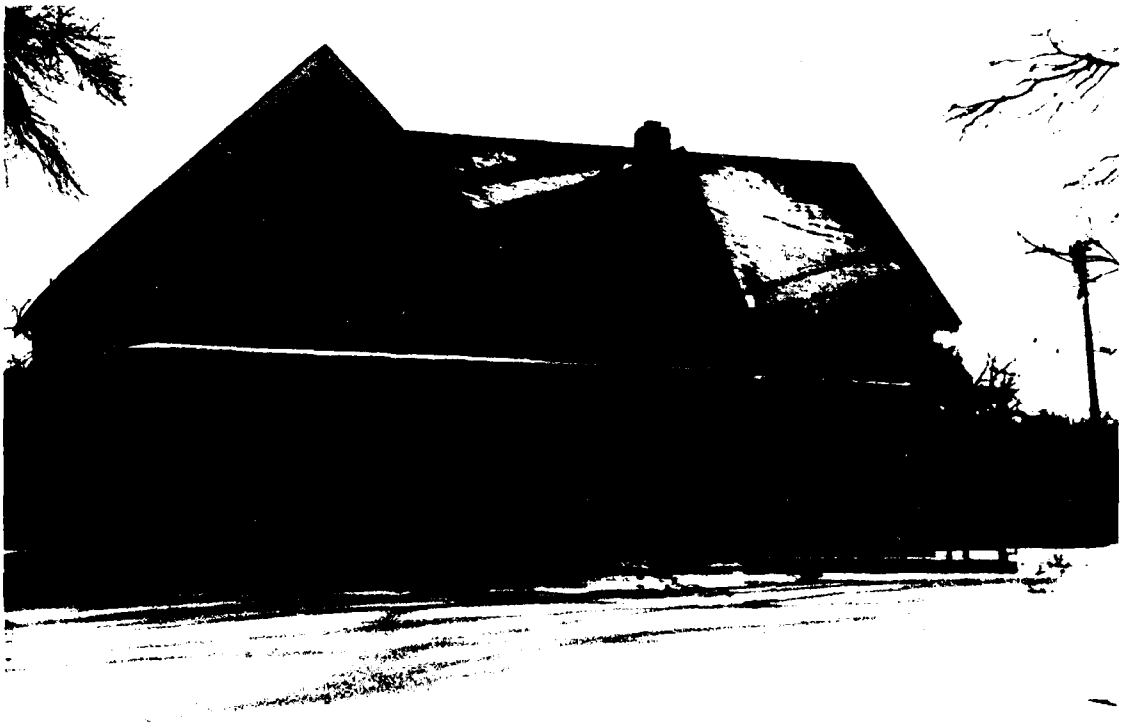
Early permanent settlement of Grand Forks commenced in 1868, when Nicholas Hoffman and August Logan built a log house and stage station on the west bank of the river at what is now the city. The first Red River steamboat was built at Grand Forks in the winter of 1868-70, although Red River steamboating had been going on since 1859. A post office was first established in 1870. In 1873 the Hudson Bay Company built its headquarters at Grand Forks for the company's Upper Red River Valley operations.

North Dakota was admitted to the United States on 2 November 1889. Grand Forks County was created by the 10th session of the Territorial legislature in 1873. Organization of the county government was completed the following year. The plat of the original townsite was filed in 1875 by Captain Alexander Griggs, on 90 acres of his homestead. The village was organized in 1878, followed by incorporation as a city in 1881.

The first area newspaper, the "Plaindealer," was established in 1875. The "Herald," predecessor of the city's present newspaper, was established in 1879. The Great Northern Railroad reached Grand Forks in 1880, giving a sudden additional impetus to agricultural and other growth in the area. The first bridge across the Red River at Grand Forks was a pontoon bridge in 1878, followed by two steel bridges in 1889. From a population of about 33 in 1871, the city population grew to between 12 and 13,000 in 1909.

Polk County and the East Grand Forks area were similarly occupied by the early traders, trappers and subsequent settlers. Mr. William C. Nash was the first settler in East Grand Forks in 1868. Polk County was created on 27 July 1858, from the old territorial county of Pembina, just shortly after Minnesota was admitted as a State on 11 May 1858. The county was subsequently divided four times before attaining its present size. The first division occurred in 1862, when a strip of land along the south boundary was allotted to Clay County. The county was divided again in 1866, when all lands along the eastern portion between Ranges 38 and 39 became part of Beltrami County. The fourth and last partitioning occurred when an irregular portion of Central and Northwest Townships was formed as Red Lake County.

The National Register of Historic Places lists two historic sites in Grand Forks and none in the Minnesota portion of the study area. The North Dakota sites include the Oxford House at the University of North Dakota and the U.S. Post Office and Court House in the city. The North Dakota State Historical Society lists numerous historic sites, principally historic buildings and townsites, in the Grand Forks study area, as tabulated in Table 21 and shown on Plate 7. Other literature indicates two additional sites: the Northwest Company building (descendent of Hudson Bay Company); and the AFC Grand Forks, 1830-1832. Other locally important historic sites include the restored Campell House and old post office at the Pioneer Women's Museum in Grand Forks and the old Great Northern Railroad Depot in Grand Forks.



Campbell House

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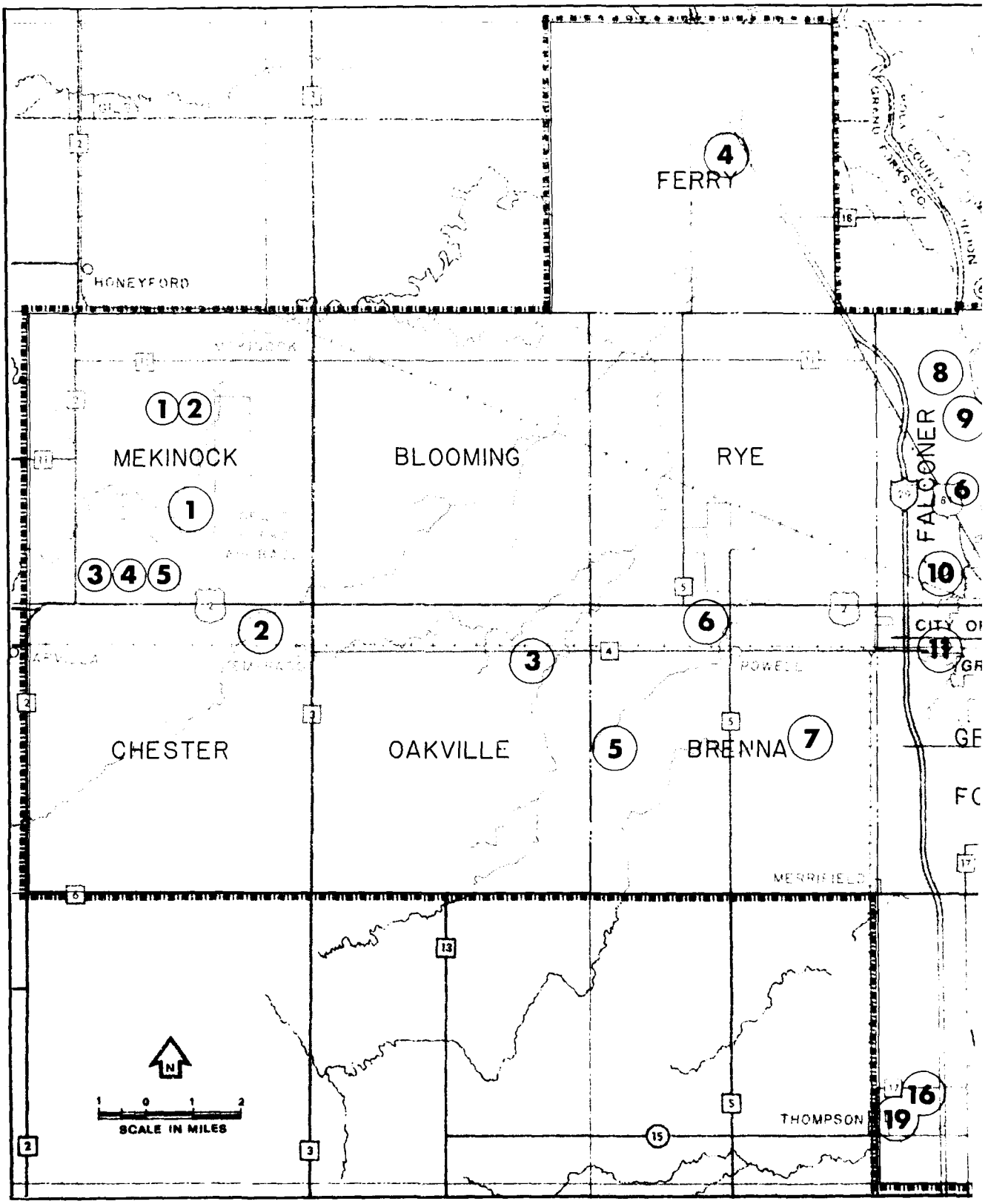
Oxford House

TABLE 21

HISTORIC SITES IN THE GRAND FORKS AREA

STATE County (Map Ref. No.)	Bldg. or Site Name	Location	National Register
	HISTORIC SITES		
NORTH DAKOTA **Grand Forks County**			
1	Historic, rural church (1884)	SW¼, NW¼, NW¼, Sec. 27 Mekinock Twn.	
2	Historic, rural school (1884)	SW¼, SE¼, Sec. 2, Chester Twn.	
3	Historic, Ojata Townsite (1884)	Ctr. of line between Sections 2 and 11, Oakville Twn.	
4	Historic, Manvel Townsite (1884)	NE¼, Sec. 15, Ferry Twn.	
5	Historic, rural school (1884)	NE¼, NE¼, Sec. 19, Brenna Twn.	
6	Historic, rural school (1884)	SW¼, NE¼, Sec. 4, Brenna Twn.	
7	Historic, rural school (1884)	NE¼, NE¼, Sec. 23, Brenna Twn.	
8	Historic, rural school (1884)	NE¼, NW¼, Sec. 8, Falconer Twn.	
9	Historic, rural school (1884)	SW¼, SW¼, Sec. 16, Falconer Twn.	
10	Historic, rural school (1884)	NW¼, SE¼, SE¼, Sec. 32, Falconer Twn.	
11	Oxford House	University of North Dakota, Grand Forks	*
12	U. S. Post Office and Court House	102 North 4th Street, Grand Forks	*
13	Campell House		
14	Historic, rural school (1884)	Ctr., NW¼, Sec. 12, Walle Twn.	
15	Historic, rural school (1884)	SW¼, SE¼, Sec. 23, Walle Twn.	
16	Historic, rural school (1884)	Ctr., NE¼, Sec. 30, Walle Twn.	
17	Historic, rural school (1884)	NE¼, NW¼, Sec. 25, Walle Twn.	
18	Historic, rural church (1884)	SW¼, NW¼, Sec. 26, Walle Twn.	
19	Historic, Thompson Townsite (1884)	W½, SW¼, Sec. 30, Walle Twn.	
20	Historic, Walle Post Office (1884)	NE¼, SE¼, Sec. 25, Walle Twn.	
MINNESOTA **Polk County**			
	None		
	PREHISTORIC-ARCHEOLOGICAL SITES		
NORTH DAKOTA **Grand Forks County**			
1	Prehistoric, Burial mound (?)	Sec. 22, Mekinock Twn.	
2	Prehistoric, Site (?)	Sec. 22, Mekinock Twn.	
3	Prehistoric, Burial area (?)	Sec. 31, Mekinock Twn.	
4	Prehistoric, Burial mound (?)	Sec. 31, Mekinock Twn.	
5	Prehistoric, Burial mound (?)	Sec. 31, Mekinock Twn.	
6	Prehistoric, Site (?)	Sec. 28, Falconer Twn.	
MINNESOTA **Polk County**			
7	Prehistoric, Mound	Huntsville Twn.	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FALCONER
CHESTER
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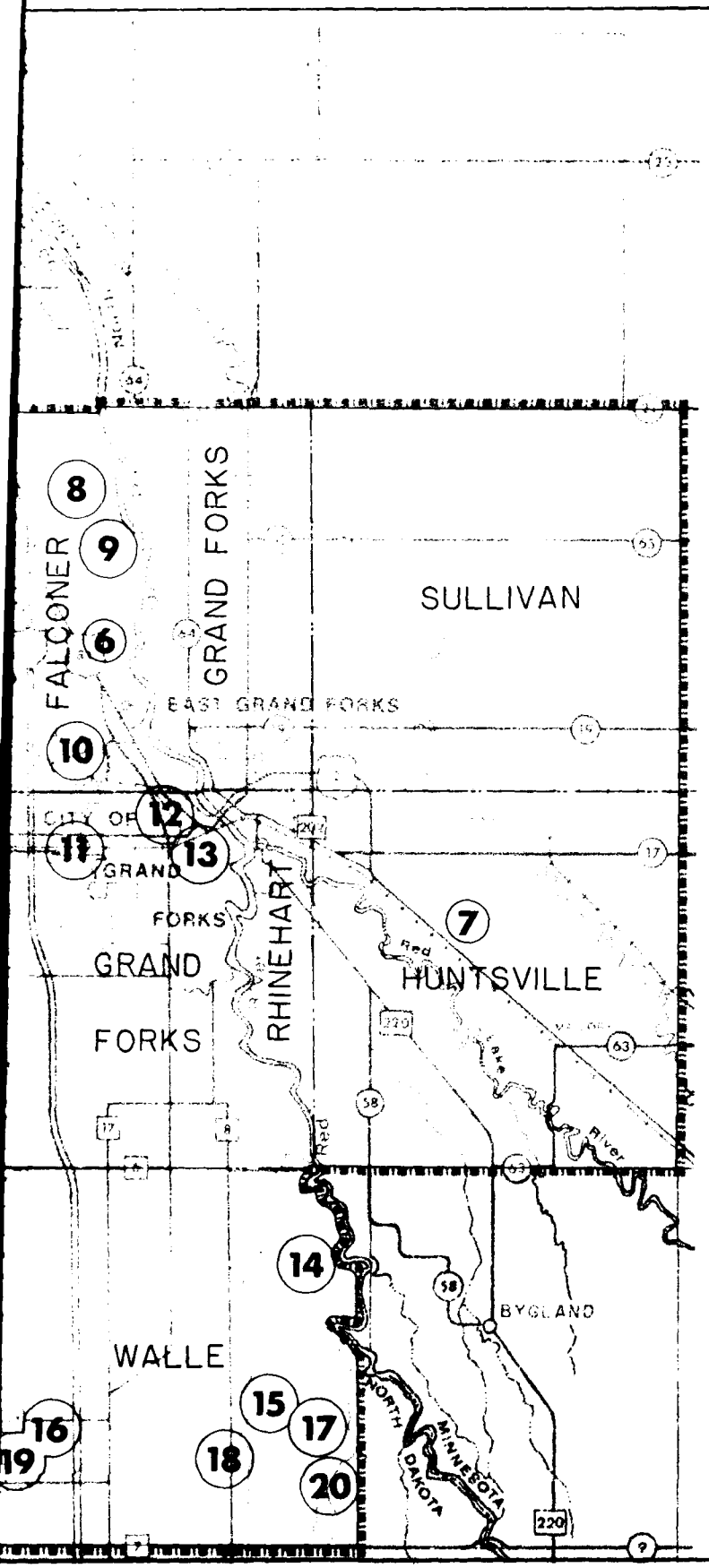
SCALE IN MILES



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

(7) ARCHEOLOGICAL SITE NUMBER

(20) HISTORICAL SITE NUMBER

NOTE: SEE TABLE 21 FOR NUMBER LISTING OF ARCHEOLOGICAL AND HISTORICAL SITES.

SOURCE: REFERENCES 98,99,100,101.

PLATE 7

SOCIAL ORGANIZATION

INTRODUCTION

A social system includes the characteristics of individuals comprising the system, and the organizational forms they have adopted to meet both basic human needs and the cultural values which have evolved. The content of a social system, as it is presented here, can be divided into three categories: (1) the distribution of individual characteristics among the members of the population; (2) the manner in which their behavior is organized to meet their needs and values; and (3) the resources and services used to support their fundamental activities.

The identification of population characteristics is important in the planning process. Such factors as population density, distribution by age, land use and property values are essential aids to the planner in assessing quantity and geographic location of need, future projections of need, and areas and groups which will be affected by decisions made during the study.

The social organization of behavior in a community is also a primary consideration in a planning study. Governmental organization, economic base, occupational structure and education define the needs and constraints of a community and establish the practical parameters for levels of local participation in the planning process. Information about organized social structure provides understanding of how contemplated changes in any structural attribute may have indirect effects on other attributes and the overall organization of the community.

Social support services are important concerns in the identification of the needs and desires of a community. Community facilities, recreation, transportation and utilities express the community's perceptions of vital services, recreational needs and demands which might be affected by possible changes in local use of resources.

DEMOGRAPHY

POPULATION DENSITY

Population densities vary greatly over the study area, with various smaller areas showing contrasting changes between 1960 and 1970. Whereas Grand Forks County increased in density from 33.8 to 42.5 persons per square mile, the city of Grand Forks decreased in areal density from 6,065 to about 4,200 persons per square mile, due mainly to annexation of lower density suburban areas. In contrast, East Grand Forks increased in population density from about 2,670 to 2,900 persons per square mile, while Polk County decreased about 5 percent from 18 to 17.1 persons per square mile. Population densities per square mile for census enumeration districts within the study area are listed in Table 22 and shown graphically on Plates 8 and 9.

Of the smaller communities, Emerado and Thompson have shown marked density increases, with a 38 percent increase in Thompson between 1960 and 1970. Population density doubled at the Air Force Base, decreased 15 percent at Manvel, and declined sharply at Mekinock. Table 22 and Plates 8 and 9 show a sudden decrease in population density from urbanized to rural areas.

TABLE 22

POPULATION DENSITY

Grand Forks Area

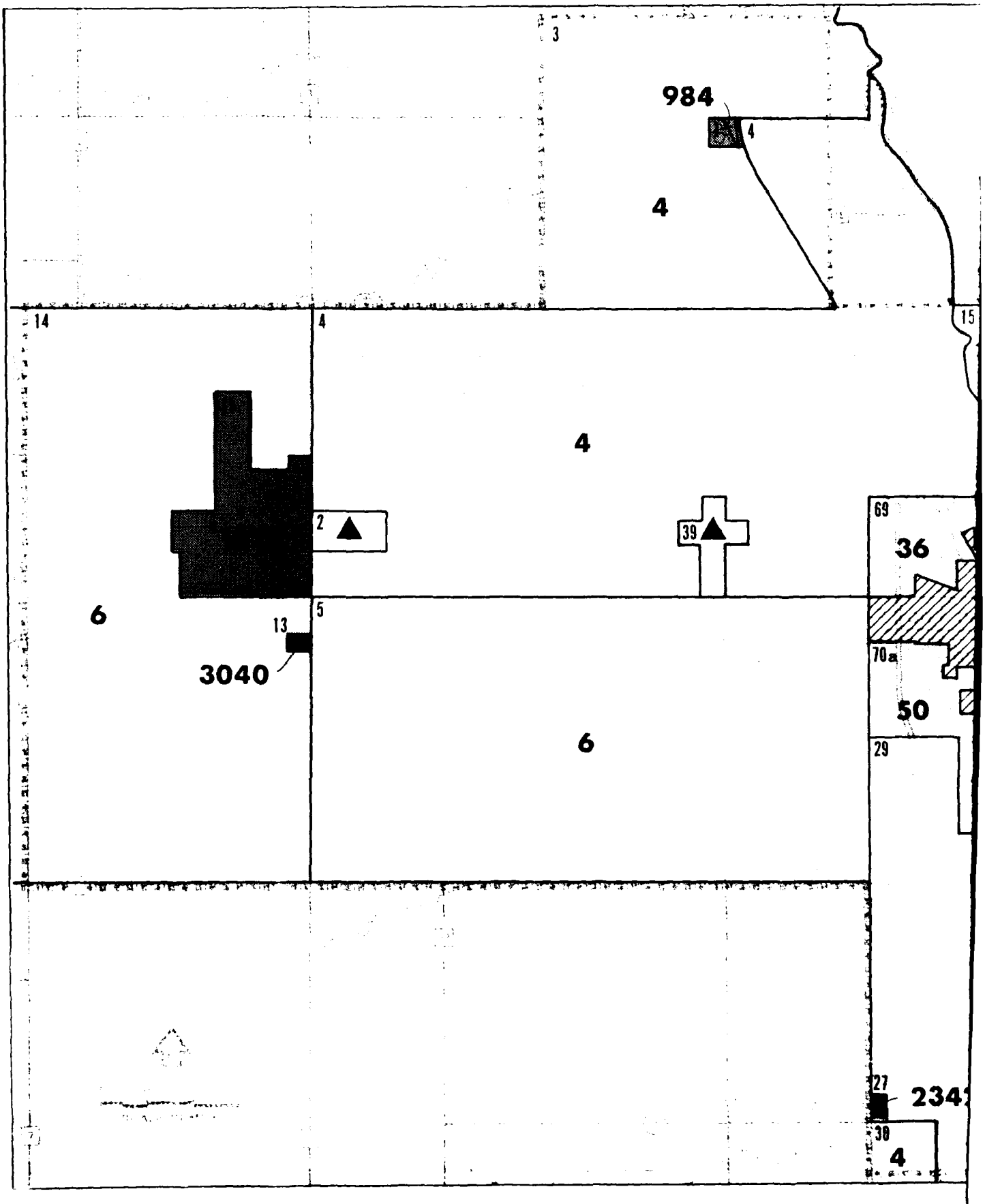
Enumeration District	Population Per Square Mile	Enumeration District	Population Per Square Mile
32	4,541	59	3,992
33	No Data	60	3,400
34	3,135	61	6,619
35	8,175	62A	7,450
36	5,305	62B	6,300
37	7,672	63A	9,736
38A	3,306	63B	8,642
38B	10,300	64	6,752
39	No Data	65	7,626
39 (Airport)	No Data	66A	2,425
40	242	66B	2,830
41A	No Data	66C	5,865
41B	12,344	67	7,078
42	3,565	68	7,450
43	6,829	69	36
44	5,340	70A	50
45	10,144	70B	181
46	8,233	11A	1,074
47	6,100	12	No Data
48	4,950	13	3,040
49	4,850	14	6
50	7,667	01	984
51	11,080	02	No Data
52	6,107	03	4
53	7,082	04	4
54	893	05	6
55	4,057	27	2,342
56	10,729	28	No Data
57	9,256	29	6
58	5,414	30	4

TABLE 22 CON'T

POPULATION DENSITY

East Grand Forks Area

Enumeration District	Population Per Square Mile
16	1,580
17	5,033
18	1,969
19	3,444
20	5,014
21	4,926
22	3,483
23	No Data
24	1,327
25	5,234
26	3,849
27	6,388
15	24
29	14
28	97
14	54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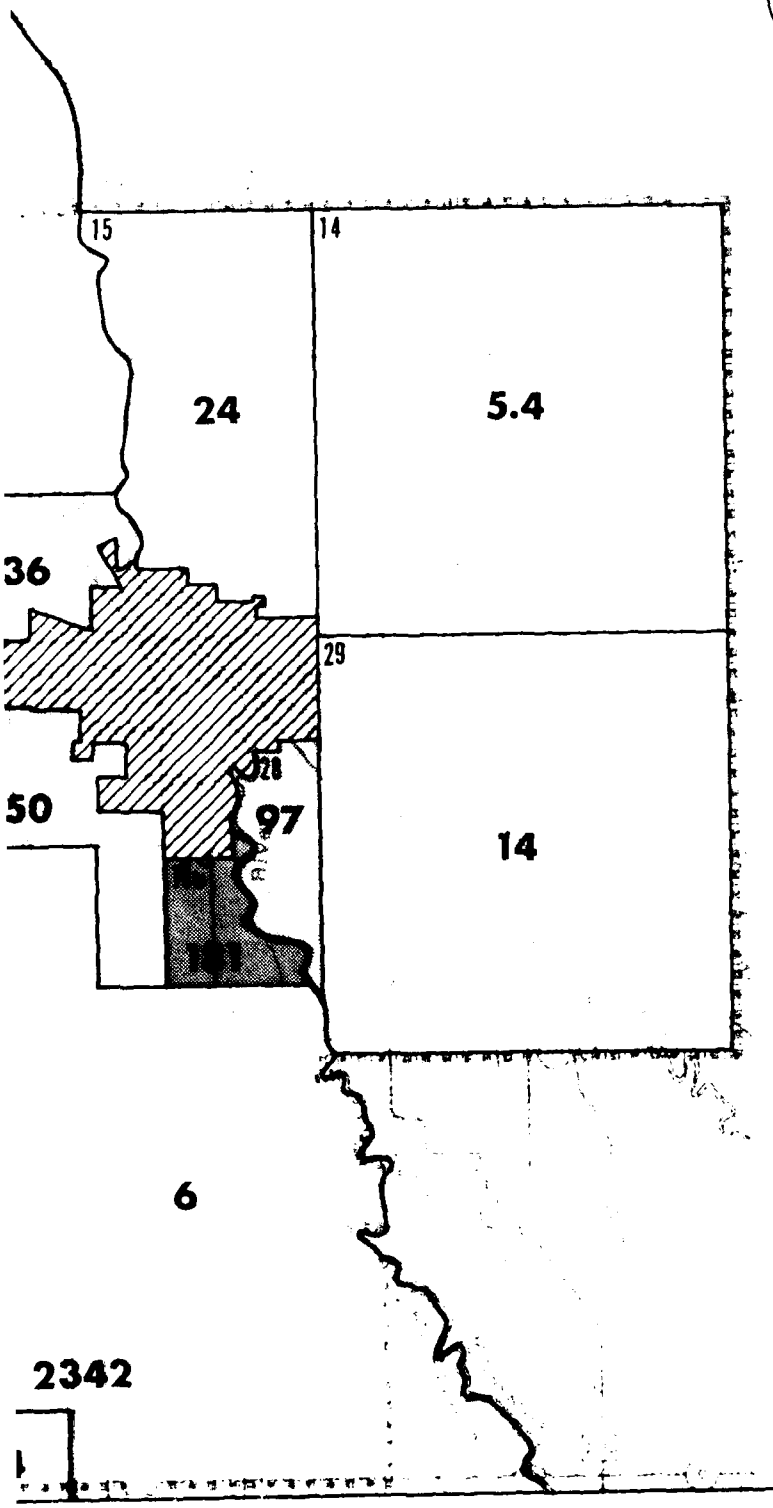
4



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

POPULATION DENSITY
OF RURAL AREAS OUTSIDE THE
GRAND FORKS – EAST GRAND FORKS
URBAN AREA

PERSONS PER SQUARE MILE
GIVEN FOR EACH ENUMERATION DISTRICT

14 NUMBER AND DISTRICT BOUNDARY

PERSONS PER SQUARE MILE

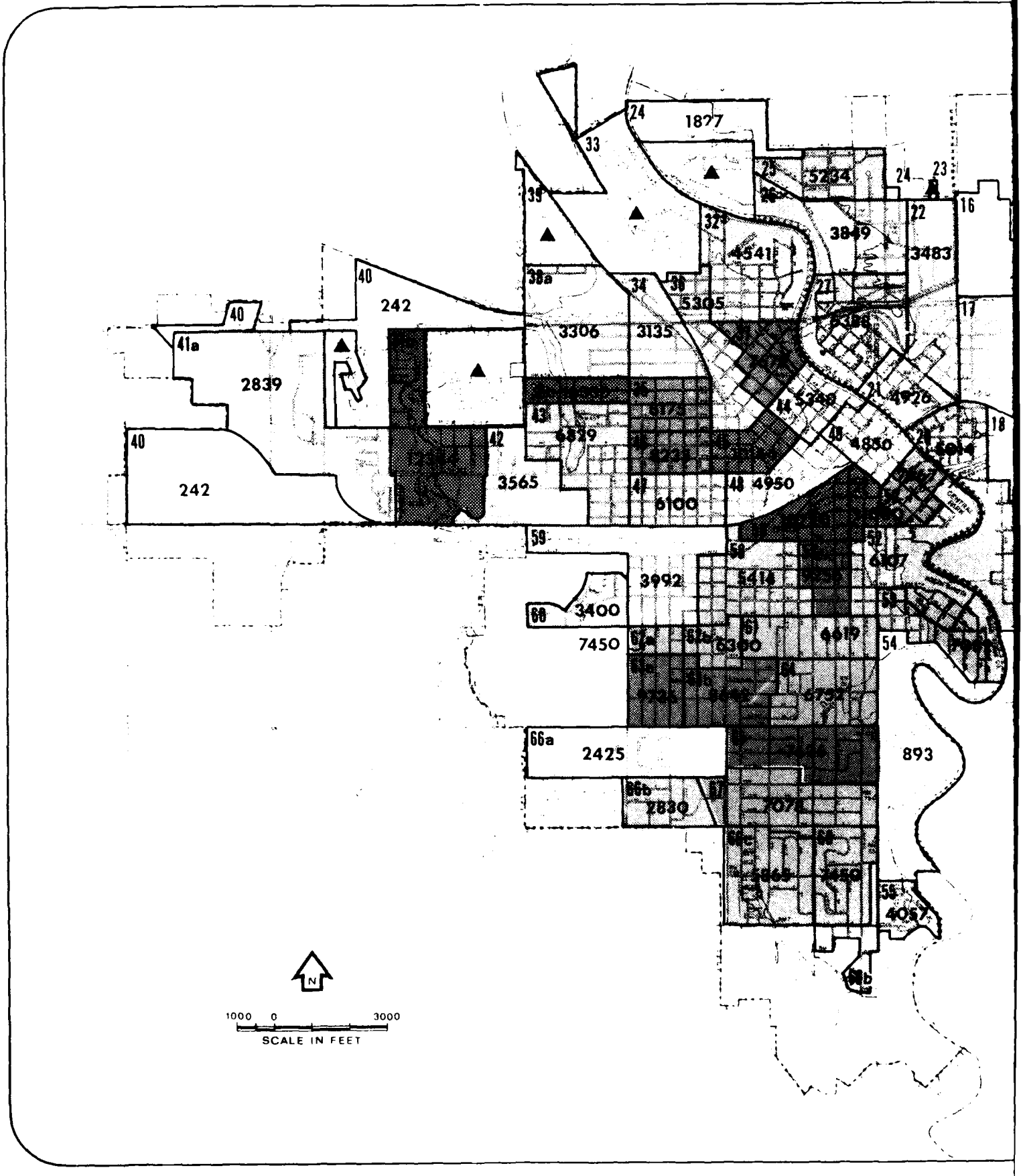
- 0–25
- 26–50
- 51–100
- 101–1000
- 1000+

▲ DATA NOT AVAILABLE

POPULATION DENSITY FOR THE
GRAND FORKS – EAST GRAND FORKS
URBAN AREA PRESENTED
ON PLATE 9

SOURCE: REFERENCE 156.

PLATE 8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5305
3306
3135
2839
242
3565
6100
4950
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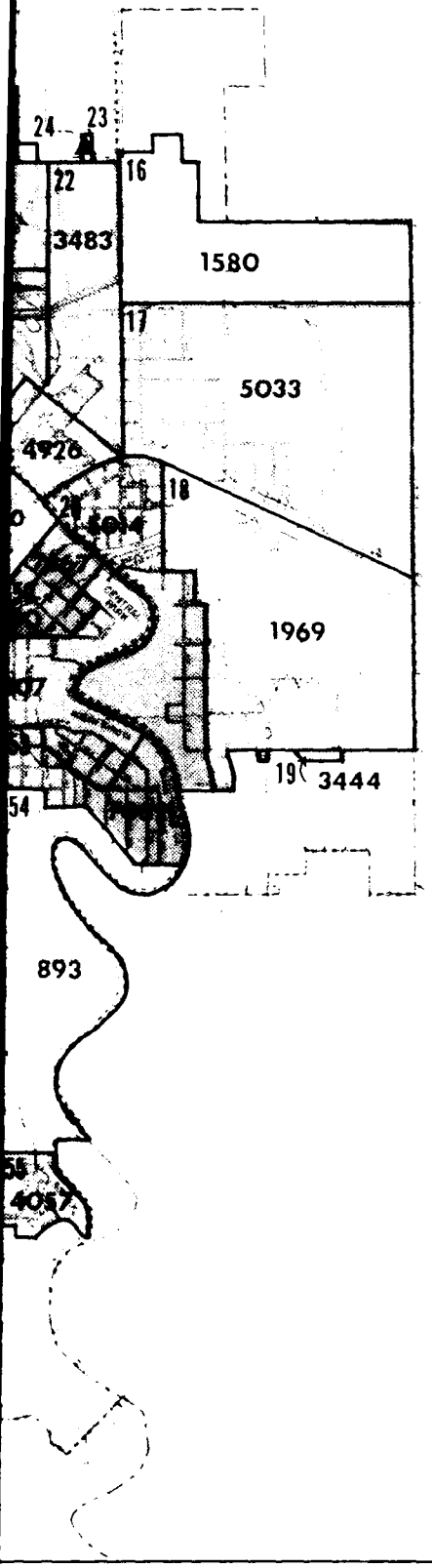
4850
3992
3400
7450
6390
4619
4057
2425
893
2830
1000 0 3000
SCALE IN FEET



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

POPULATION DENSITY OF THE
GRAND FORKS - EAST GRAND FORKS
URBAN AREA

PERSONS PER SQUARE MILE
GIVEN FOR EACH ENUMERATION DISTRICT

17 NUMBER AND DISTRICT BOUNDARY

PERSONS PER SQUARE MILE

- 0-1000
- 1001-2500
- 2501-5000
- 5001-7500
- 7501-10000
- 10000+
- ▲ DATA NOT AVAILABLE

POPULATION DENSITY FOR RURAL AREAS
OUTSIDE GRAND FORKS - EAST GRAND FORKS
PRESENTED ON PLATE 8

SOURCE: REFERENCE 156.

PLATE 9

POPULATION DISTRIBUTION BY AGE

Age characteristics of the study area population vary, but sh rural population in Grand Forks County and a significantly older County, in terms of median age. Median ages for Grand Forks and (23.1 and 23.2, respectively, in 1970, while median East Grand For were 24.4 and 30.5 years, respectively. The spatial distribution of t older age groups for the urban and rural areas is shown by census Plates 10 and 11, and tabulated in Table 23.

Of significant interest is the effect of the declining birth r other factors on the population age distribution in the area. In Pc there was a 33 percent decline in the under-5 age group between 19 the 15-24 age group increased about 32 percent, while the over-65 (percent over 1960 levels. To illustrate an aging Polk County pop group increased from a 9.2 percent share in 1950 to a 14.4 percen

Another notable contrast is the marked difference in median area townshi, s, in contrast to that of the entire county. Of the fou adjacent to East Grand Forks (see Plate 10), Grand Forks Townshi age of 20.6, as compared to 30.6 for Polk County.

In Thompson, the population increased 83 percent, from 291 i this increase, the 25-34 age group represented 31 percent of this gr the under-5 and 5-15 age groups, with 26 and 25 percent, respe attributed to the large number of younger couples buying or build commuting to work in the Grand Forks area. Only the over-65 ag over the 5-year period. From a disproportionately large number of the recent influx of younger persons has evened the distribution so the population is under 34 years, as compared to only 55 percent

TABLE 23

POPULATION DISTRIBUTION BY AGE GROUPS

East Grand Forks Area

Enumeration District	AGE GROUPS 0 - 17 #	%	18 - 64 #	%	65+ #	%
16	141	44.6	175	55.4	0	0.0
17	301	28.5	627	59.3	129	12.2
18	512	46.5	562	51.0	27	2.5
19	16	51.6	15	48.4	0	0.0
20	454	43.1	518	49.2	81	7.7
21	64	13.7	276	59.0	128	27.3
22	213	34.7	321	52.4	79	12.9
24	23	16.8	13	9.5	101	73.7
25	304	40.0	449	59.2	6	0.8
26	334	45.2	385	52.1	20	2.7
27	452	37.7	596	49.6	153	12.7
15 (Grand Forks Twn)	204	54.6	155	41.4	15	4.0
29	264	52.4	230	45.6	10	2.0
28	153	44.9	159	46.6	29	8.5
14	75	38.3	76	38.8	45	22.9

TABLE 23 CON'T

POPULATION DISTRIBUTION BY AGE GROUPS

Grand Forks Area

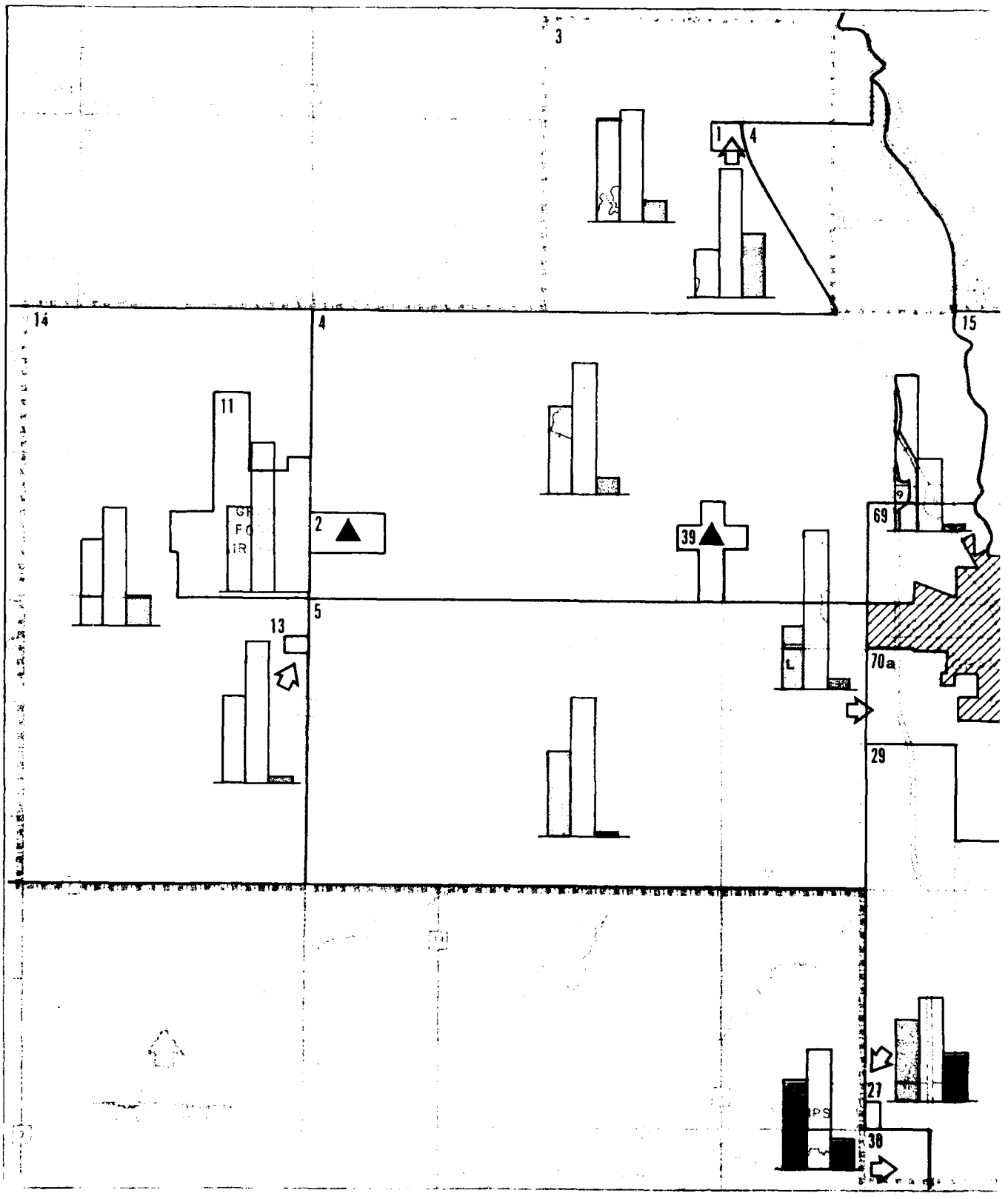
Enumeration District	AGE GROUPS 0 - 17 #	%	18 - 64 #	%	65+ #	%
32	451	37	642	54	113	9
34	265	50	264	49	4	1
35	352	36	518	54	95	10
36	300	33	501	56	101	11
37	249	29	394	47	201	24
38A	307	32	620	65	32	3
38B	308	43	385	54	23	3
40	85	43	114	57	0	0
41A	345	27	918	73	0	0
41B	294	7	3,642	92	14	1
42	66	10	560	86	27	4
43	515	32	1,044	64	70	4
44	100	19	315	59	119	22
45	286	30	502	56	125	14
46	216	29	473	64	52	7
47	186	23	536	68	71	9
48	111	16	538	74	76	10
49	56	9	388	67	138	24
50	145	21	428	62	117	17
51	152	27	288	52	114	21
52	648	40	813	49	188	11
53	347	29	610	50	247	21
54	125	33	210	56	40	11
55	149	52	135	48	0	0
56	327	31	658	61	87	8
57	222	26	455	55	156	19
58	402	35	617	54	118	11

TABLE 23 CON'T

POPULATION DISTRIBUTION BY AGE GROUPS

Grand Forks Area

Enumeration District	AGE GROUPS 0 - 17 #	%	18 - 64 #	%	65+ #	%
59	502	45	573	51	43	4
60	186	55	154	45	0	0
61	401	37	537	51	123	12
62A	124	42	170	57	4	1
62B	134	35	238	63	6	2
63A	509	51	479	47	23	2
63B	412	49	371	43	70	8
64	501	38	650	50	152	12
65	609	42	768	53	72	5
66A	321	44	334	56	0	0
66B	163	29	295	52	108	19
66C	339	44	480	54	14	2
67	719	5	11,391	94	58	1
68	559	47	614	51	19	2
69	102	66	48	31	4	3
70A	99	27	247	68	18	5
70B	244	44	291	52	20	4
11	4,220	40	6,304	60	19	0
13	170	37	273	60	13	3
14	289	36	408	51	107	13
01	49	20	132	54	65	26
03	244	44	263	47	48	9
04	138	37	214	56	28	7
05	144	37	228	60	11	3
27	100	35	123	44	58	21
29	211	34	331	54	71	12
30	183	38	245	50	60	12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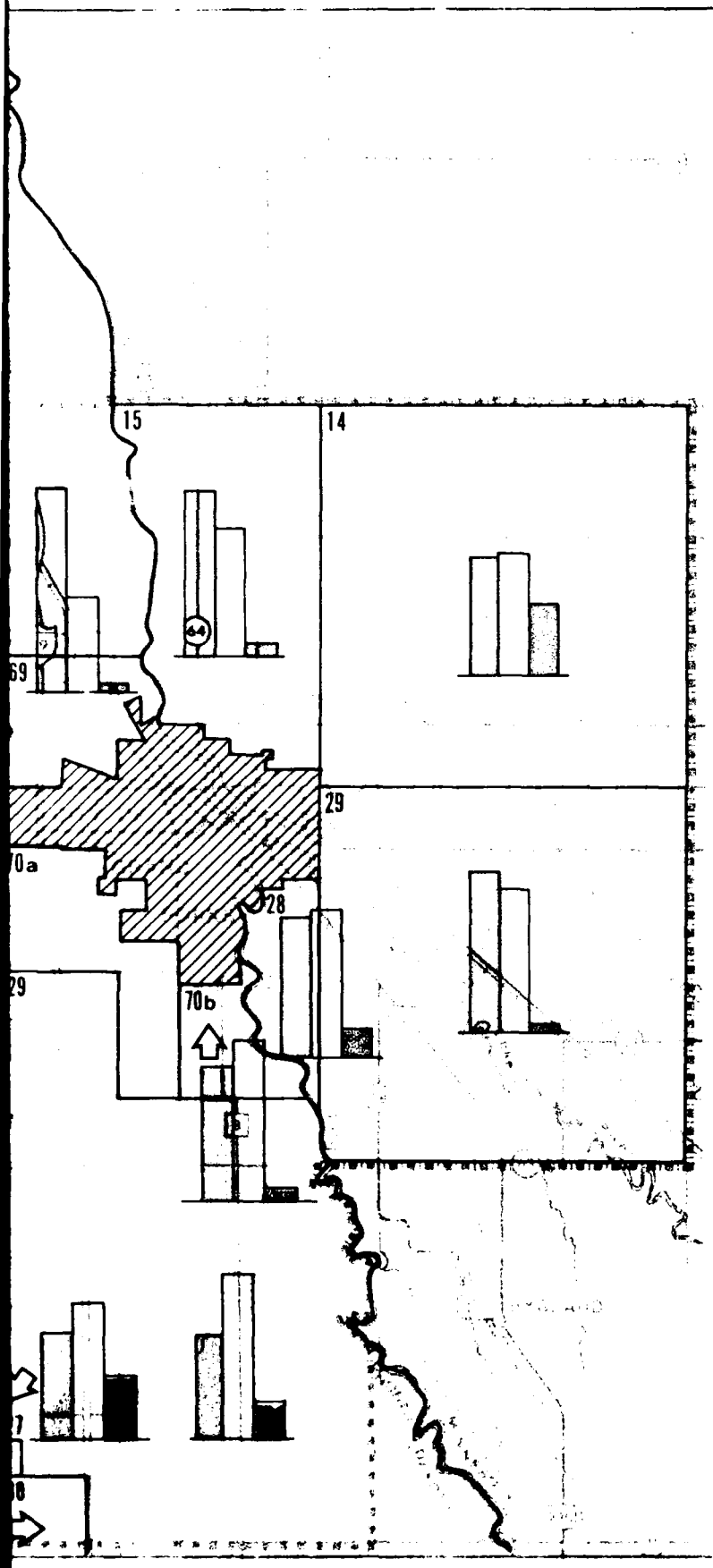
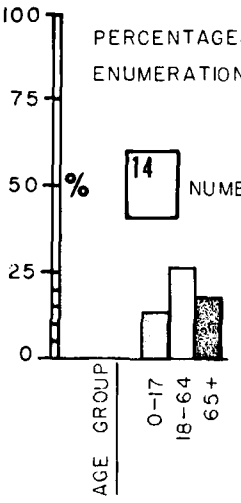


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

POPULATION DISTRIBUTION
BY AGE GROUP FOR RURAL AREAS



PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT

14 NUMBER AND DISTRICT BOUNDARY

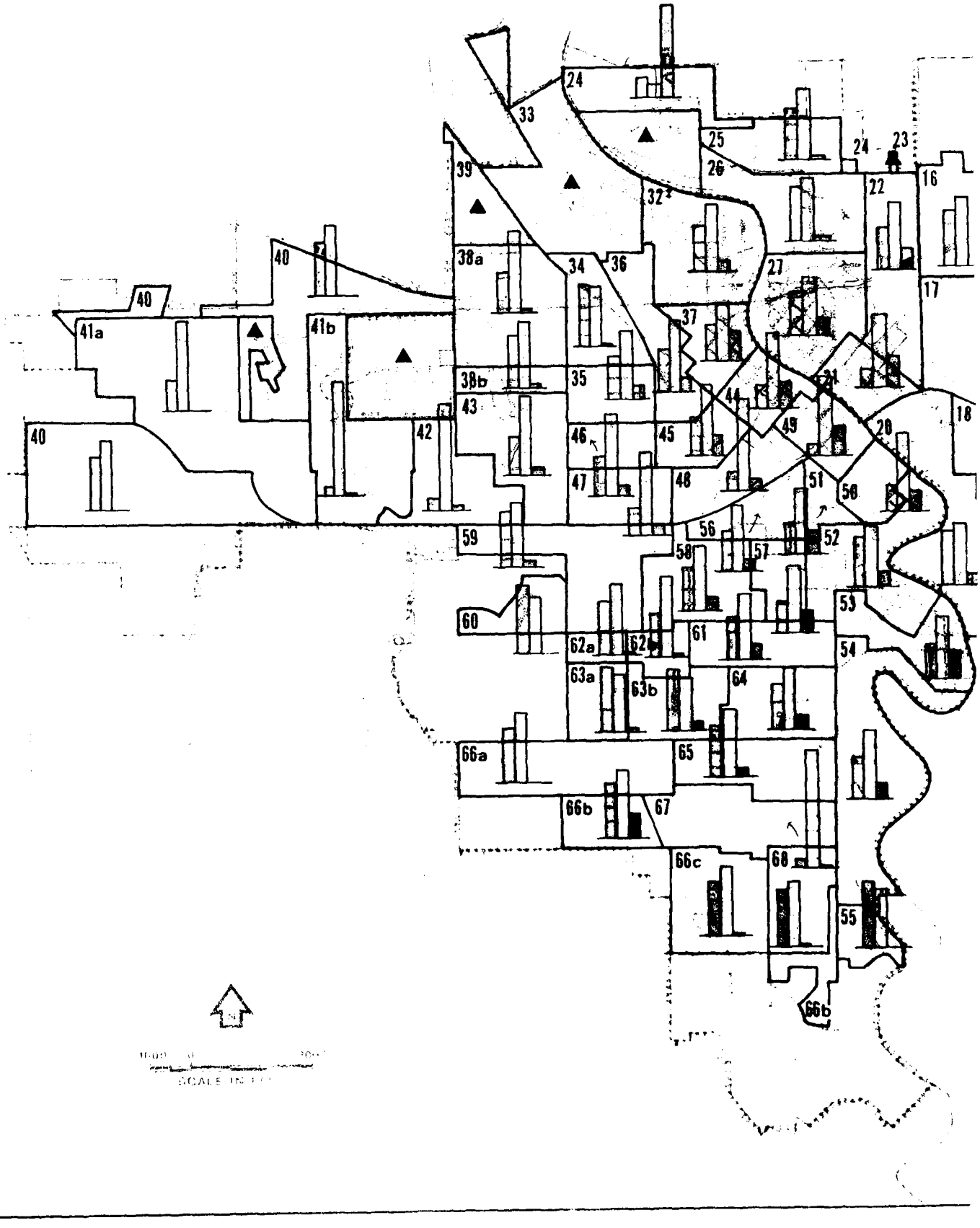
PRECISE PERCENTAGES GIVEN IN TABLE 23

▲ DATA NOT AVAILABLE

POPULATION DISTRIBUTION BY AGE GROUP FOR THE GRAND FORKS-EAST GRAND FORKS URBAN AREA PRESENTED ON PLATE II

SOURCE: REFERENCE 156.

PLATE 10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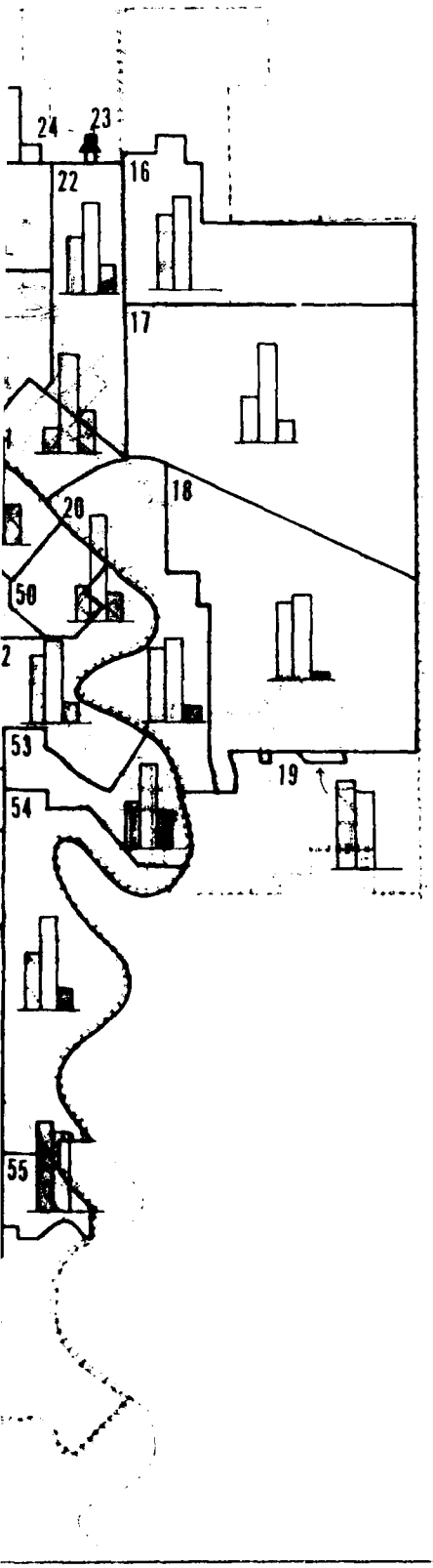
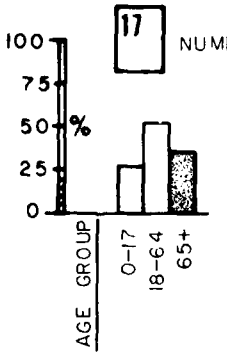


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

POPULATION DISTRIBUTION BY AGE GROUP FOR THE GRAND FORKS – EAST GRAND FORKS URBAN AREA

PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT



NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES GIVEN IN TABLE 23

▲ DATA NOT AVAILABLE

POPULATION DISTRIBUTION BY AGE GROUP FOR THE RURAL AREAS OUTSIDE GRAND FORKS – EAST GRAND FORKS PRESENTED ON PLATE 10

SOURCE: REFERENCE 156.

PLATE II

URBAN - RURAL DISTRIBUTION

Prior to 1970, population trends indicated a shift from rural to urbanized areas, as farms grew larger and the number of farms decreased. With fewer employment opportunities, many displaced rural residents sought employment in the urbanized area. Very recent but incomplete data show some reversal of this trend, as some former urbanites are leaving for the amenities of a quieter rural or small community atmosphere. Indications of this trend may be the rapid growth of Thompson and Emerado in Grand Forks County during the period 1970-76, as compared to the slower growth rate between 1960 and 1970.

In Grand Forks County during 1960, the urban and rural area (including rural communities) contained 70.8 and 29.2 percent of the population, respectively. By 1970, the urbanized and rural areas accounted for 81 and 19 percent, respectively, of the county population. Polk County urban-rural distributions represent a marked contrast for both years, with a much higher percentage of rural population. In 1960, the urban and rural populations represented 43 and 57 percent, respectively, of total population. By 1970, the urban sector grew slightly to 46 percent, while the rural sector decreased to 54 percent of the county population. In contrast to overall county patterns, the townships adjacent to densely urbanized areas will probably grow faster, due to more commuting residents. This trend may be affected by future and uncertain energy considerations. A summary of study area population and percent change between 1960 and 1970, by county, city, rural community and township is given in Tables 24 and 25.

TABLE 24

POPULATION

GRAND FORKS COUNTY, NORTH DAKOTA
STUDY AREA

Place	1960	1970	1975	% Change 1960-1970
Grand Forks County	48,677	61,102	DNA	+25.5
Grand Forks	34,451	39,008	41,601*	+13.2
Grand Forks Air Base	5,192	10,474	DNA	+101.7
Thompson	211	291	532	+37.9
Emerado	328	515	864	+57.0
Arvilla	138	DNA	DNA	---
Manvel	313	265	DNA	-15.3
Mekinock	111	DNA	DNA	---
Grand Forks Township**	92	1,083	DNA	+56.5
Walle Township	293	262	DNA	-10.6
Brenna Township	212	189	DNA	-10.8
Oakville Township	168	215	DNA	+5.6
Chester Township	168	215	DNA	+28.0
Mekinock Township	1,774	10,678	DNA	+501.9
Blooming Township	201	180	DNA	-10.4
Rye Township	137	161	DNA	+17.5
Falconer Township	308	159	DNA	-48.4
Ferry Township	296	222	DNA	-25.0

DNA - Data not available

* 1973
** Township populations exclude communities

TABLE 25

POPULATION

POLK COUNTY, MINNESOTA
STUDY AREA

Place	1960	1970	1975	% Change 1960-1970
Polk County	36,182	34,435	DNA	-4.8
East Grand Forks	6,998	7,607	8,397	+8.7
Huntsville Township**	457	461	DNA	+0.9
Sullivan Township	207	213	DNA	+2.9
Grand Forks Township	259	357	DNA	+37.8
Rinehart Township	220	416	DNA	+89.1

DNA - Data not available

Source: U.S. Census Bureau

POPULATION PROJECTIONS

Population projections for the study area have been made in recent years by Federal, State and local units of government. Population projections for the regional Economic Area 092, within which the study area is located, are shown in Figure 14. Projections for Grand Forks County and Grand Forks are shown in Figure 15. Similar projections for Polk County and East Grand Forks are given in Figure 16.

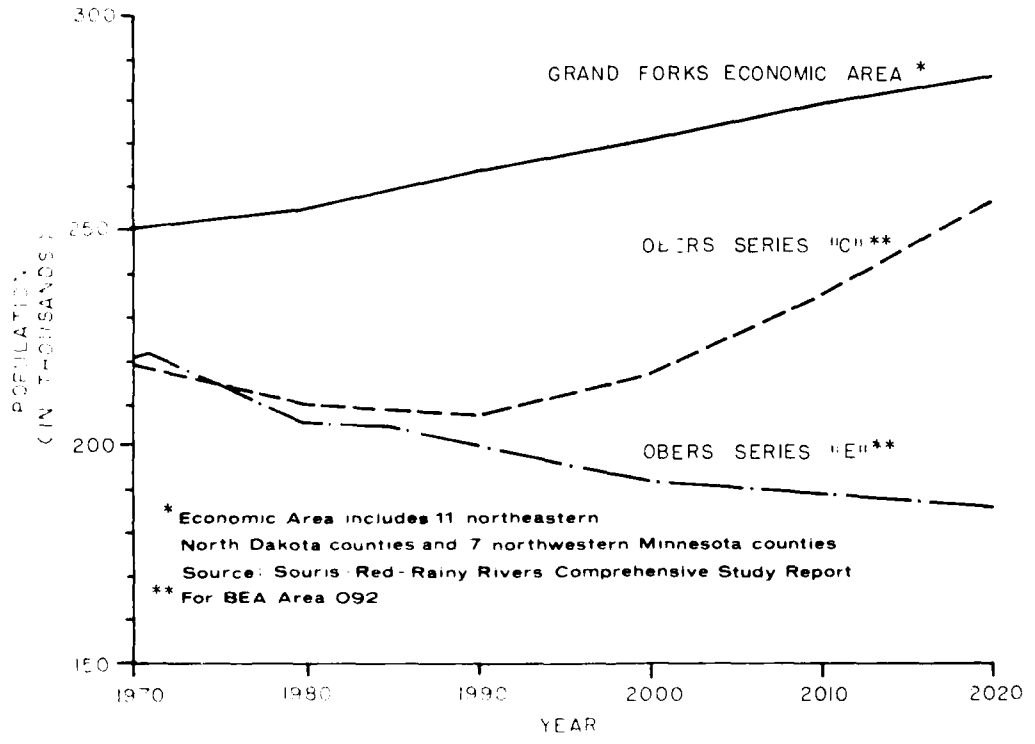


FIGURE 14

PROJECTED POPULATION - REGION

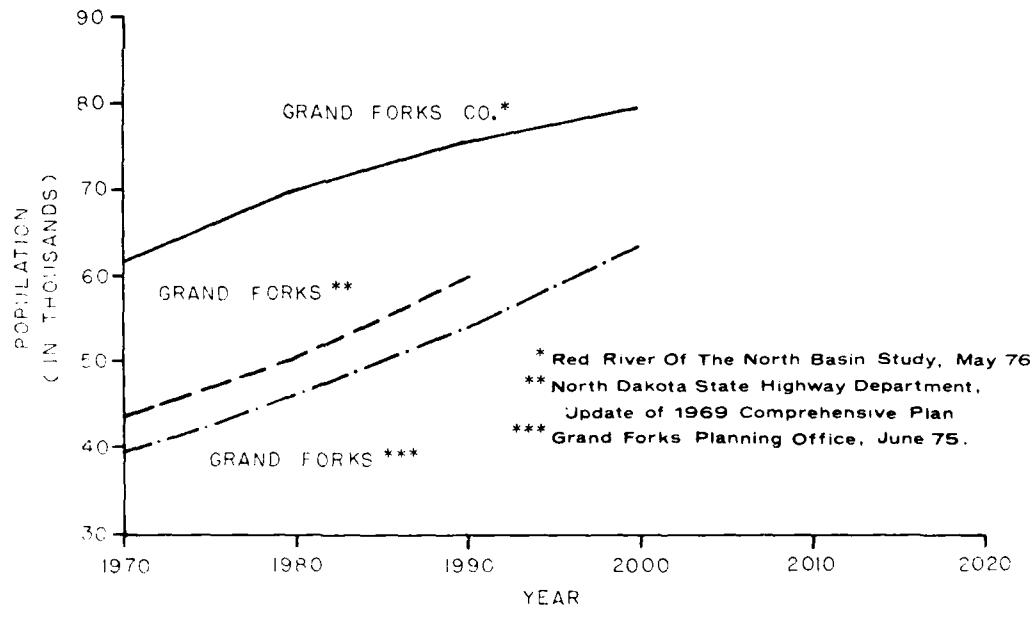


FIGURE 15

PROJECTED POPULATION - GRAND FORKS COUNTY AND GRAND FORKS

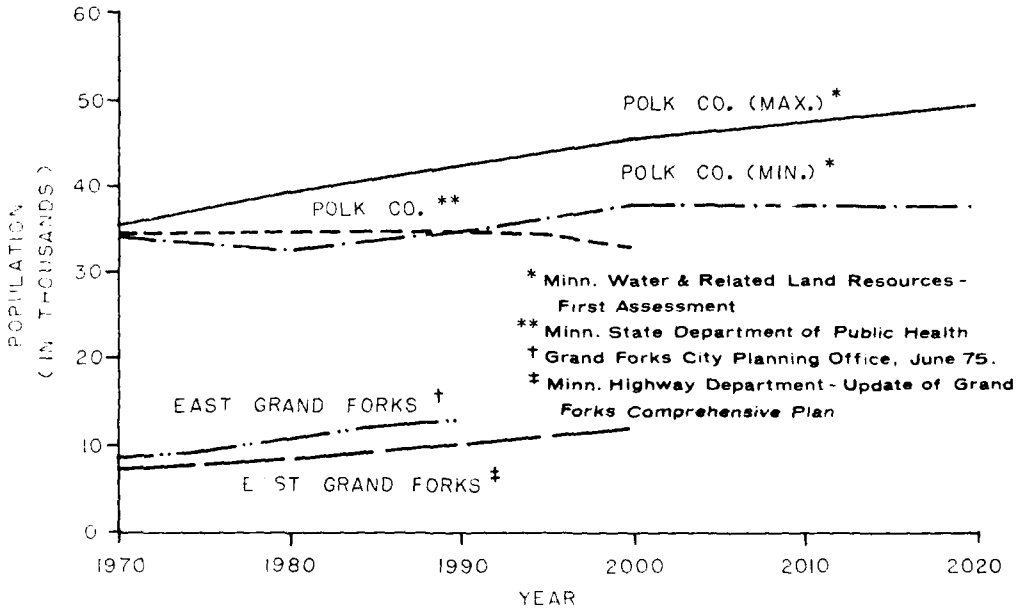


FIGURE 16

PROJECTED POPULATION - POLK COUNTY AND EAST GRAND FORKS

RACIAL DISTRIBUTION

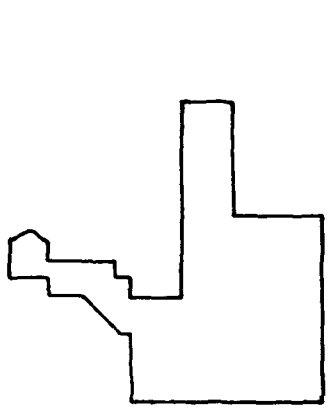
Racial minorities constitute only a small percentage c
Indians and Negroes represent the two largest groups, with 6.1 c
of the Grand Forks population, and 4.2 and 1.1 percent, res
Forks population. The largest concentrations of the Negro anc
U.S. Air Base and in Grand Forks, respectively. While the Neg
base population, the Grand Forks Indian population has shc
recent years, from 278 in 1970 to over 1,000 in 1976. A
populations, by county, principal city and the Air Base is giv
graphically on Plate 12.

TABLE 26

MINORITY GROUP POPULATIONS - 1970

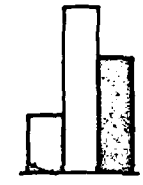
Race Classification	Grand Forks County		Grand Forks		Grand Forks Air Force Base		Polk County		East Grand	
	#	%	#	%	#	%	#	%	#	%
Negro	1,004	50.4	86	4.3	879	44.1	15	0.8	8	0
Indian	278	42.6	238	36.5	16	2.5	88	13.5	32	4
Chinese	53	44.9	49	41.5	4	3.4	7	5.9	5	4
Japanese	77	48.1	19	11.9	52	32.5	11	6.9	1	0
Other	219	44.1	101	20.3	102	20.5	55	11.1	20	4

Source: U.S. Census



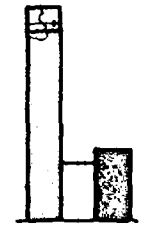
GRAND FORKS AIR FORCE BASE

MINORITY POPULATION
10.05 PERCENT OF BASE POPULATION



GRAND FORKS

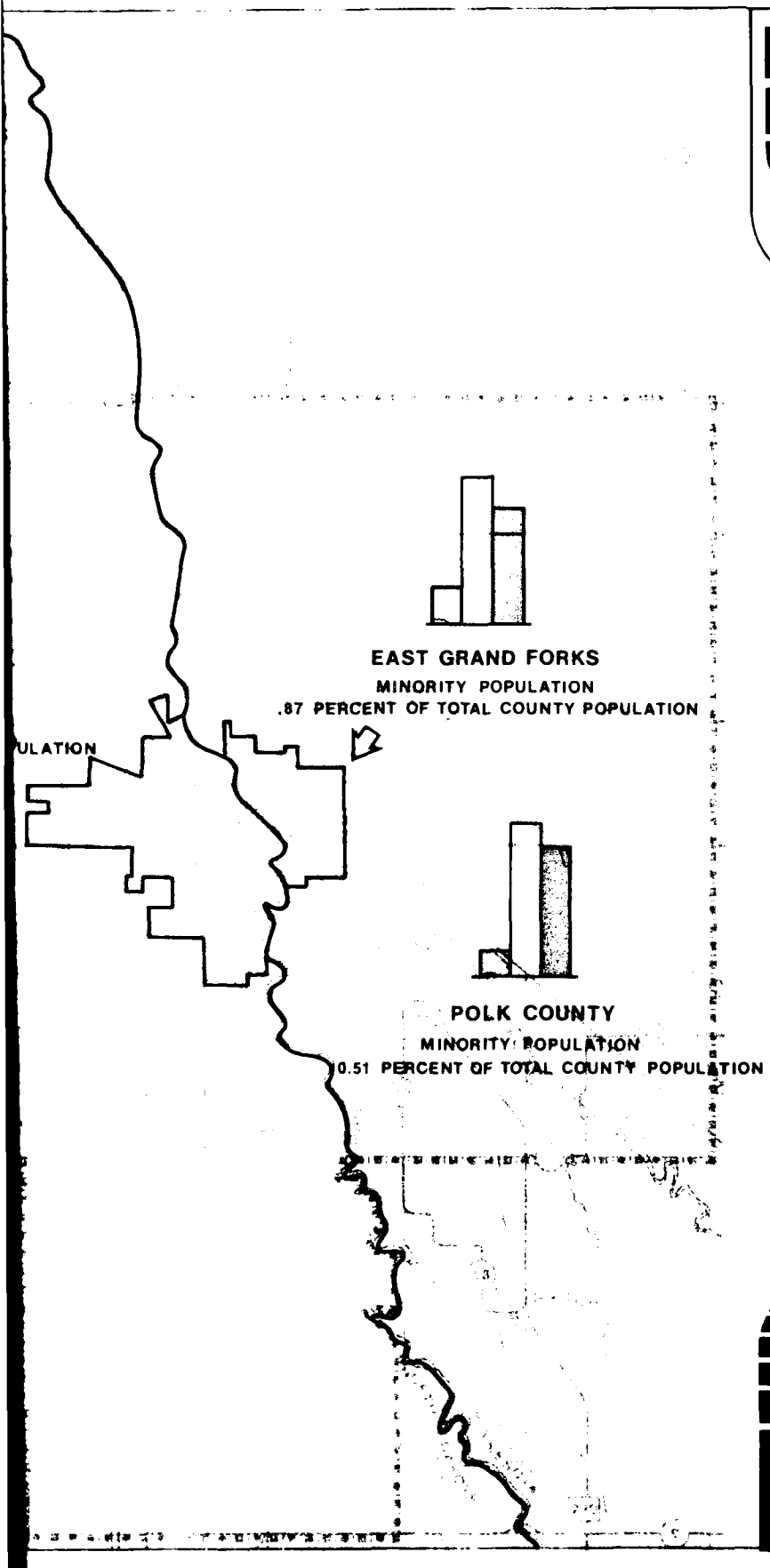
MINORITY POPUL
1.26 PERCENT OF TOTAL CI



GRAND FORKS COUNTY

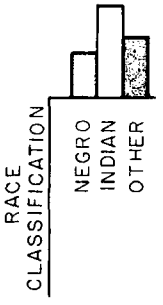
MINORITY POPULATION
2.67 PERCENT OF TOTAL COUNTY POPULATION

Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



MINORITY GROUP POPULATIONS 1970

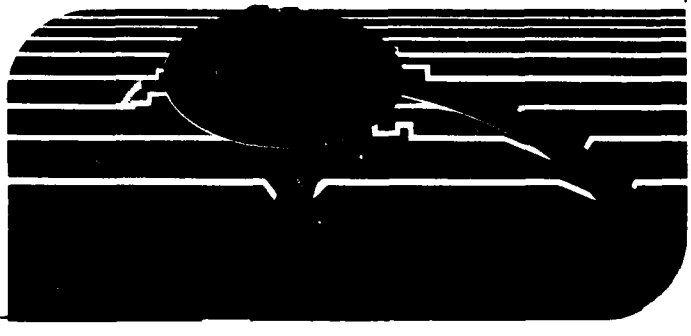
PERCENTAGE OF MINORITY POPULATIONS AND RELATION TO TOTAL POPULATION

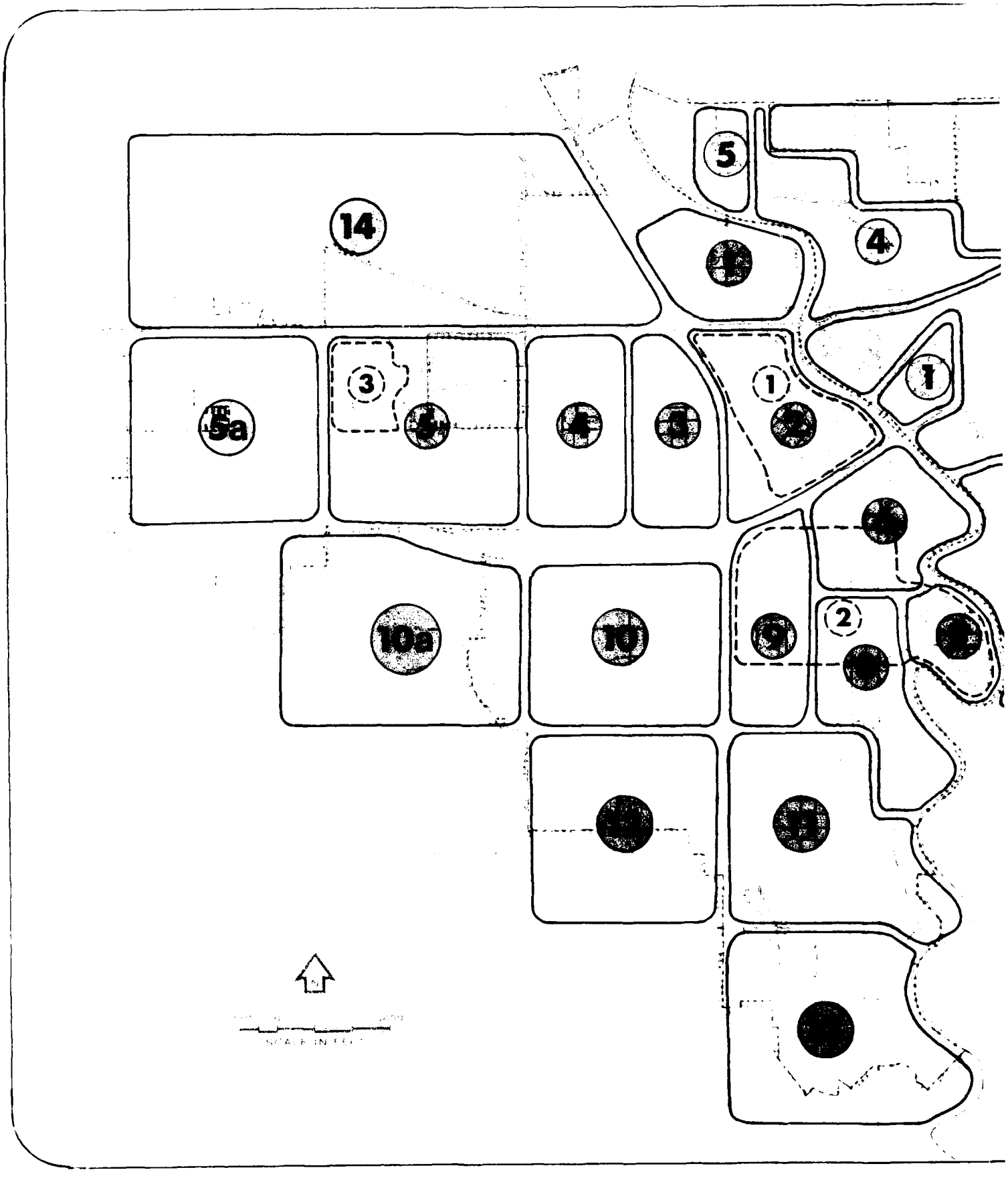


PRECISE PERCENTAGES GIVEN IN TABLE 26

SOURCE: REFERENCES 162,163.

PLATE 12

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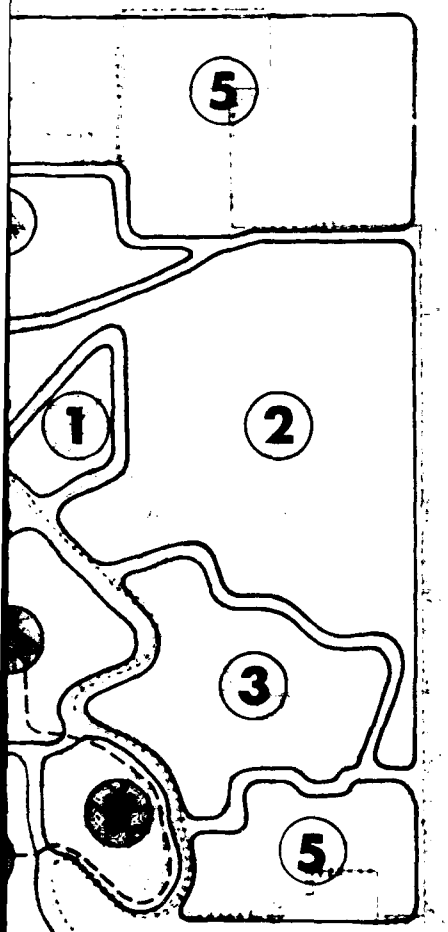


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

GRAND FORKS – EAST GRAND FORKS URBAN AREA

PLANNING DISTRICTS

GRAND FORKS		EAST GRAND FORKS	
1	RIVERSIDE PARK	1	DOWNTOWN BUSINESS DISTRICT
2	WASHINGTON	2	VALLEY
3	WINSHIP	3	CRESTWOOD
4	WEST	4	RIVER HEIGHTS
5	AGASSIZ	5	FRINGE
6	WEST PARK		
7	BELMONT		
8	LINCOLN		
9	ROOSEVELT		
10	LEWIS & CLARK		
11	BEN FRANKLIN		
12	PARKSIDE		
13	VIKING		
14	VALLEY PARK		
15	SOUTH TOWN		
16	INDUSTRIAL AREA		

NEIGHBORHOOD GROUPS

1. NEAR NORTH SIDE
2. NEAR SOUTH SIDE
3. LAKE AGASSIZ HOME-OWNERS ASSOC.

SOURCE: REFERENCE 55.

PLATE 13

ETHNIC GROUPS

Unlike many other metropolitan areas, there are few easily distinguishable ethnic concentrations in the study area. Minority race persons represent only slightly over one percent of the Grand Forks population, and are principally located in the near north side area of Grand Forks, at the University and Air Force Base, or dispersed throughout the city. Principal minority group concentrations include the native Americans in the near north side and the Negro population at the Air Force Base. Grand Forks is one of two North Dakota cities with the highest number of Indian residents, as evidenced by recent growth from 278 persons in 1970 to slightly over 1,000 in 1976. In East Grand Forks, minority races, predominantly native Americans, represent about one-half of one percent of the total city population and are fairly dispersed city-wide.

NEIGHBORHOOD GROUPS

The formation of neighborhood groups and organizations in the larger urban areas provides opportunities for interested citizens to express their opinions and enter into the decision-making process. Only a small number of such groups is located in Grand Forks, with none in East Grand Forks and the rural study area, as shown in Table 27. The general locations of identified groups, along with the planning district boundaries for the two major cities, are shown on Plate 13.

TABLE 27

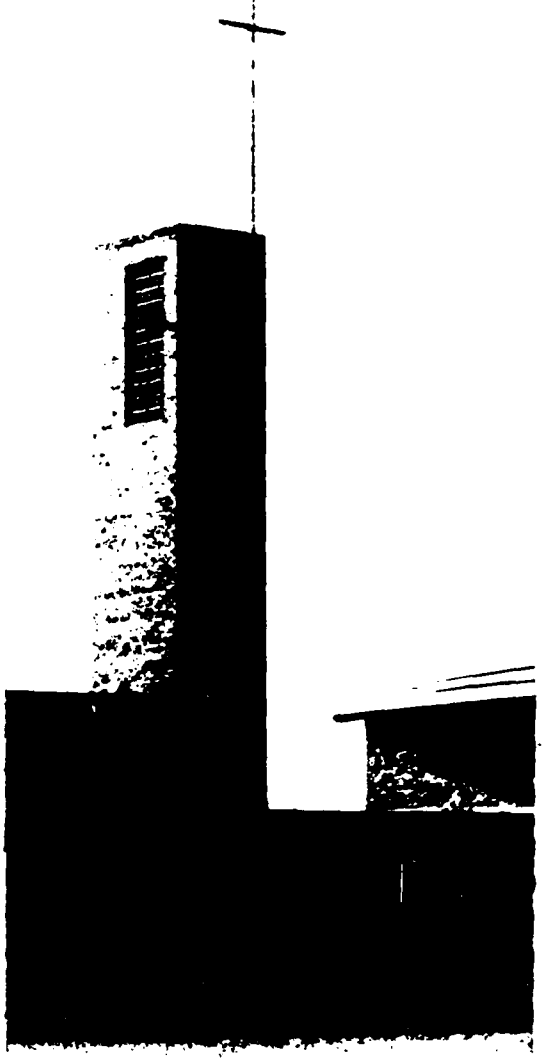
NEIGHBORHOOD GROUPS

Grand Forks

Near South Side Neighborhood Association
Near North Side Neighborhood Association
Lake Agassiz Homeowners Association

East Grand Forks

None



RELIGION

As in other pioneer communities, religion played an important role in the development and growth of the Grand Forks-East Grand Forks area. Early religious activity in the area centered around the Methodist church and Catholic missionaries. Lutheran churches then followed with the influx of settlers in the later 1800's. Over 50 church congregations are located in the area at the present time, and represent the various denominations shown in Table 28. Of these, the principal faiths are Lutheran, Baptist and Catholic, with the Lutheran faith dominant. Parochial education is provided by three elementary (Catholic) schools in Grand Forks, a Catholic elementary and high school in East Grand Forks, and the Bible Baptist Church.

TABLE 28

CHURCHES IN THE GRAND FORKS - EAST GRAND FORKS AREA

Lutheran
Baptist
Catholic
Methodist
Presbyterian
Assembly of God
Church of God
United Methodist
Episcopal
Christian Reformed
Christian Science (Scientist)
Church of Christ
Evangelical Free Church of America
Federated Church
Free Methodist
Greek Orthodox
Jehovah's Witness
Jewish
Nazarene
Salvation Army
Seventh Day Adventist
United Church of Christ
United Pentecostal
Church of Jesus Christ of Latter Day Saints
Church of Jesus Christ of Latter Day Saints (Reorganized)

CRIME

Probably due in part to its lower population and population densities, known criminal offenses per 100,000 population in North Dakota ranked lowest in the nation from 1968 through 1972. In 1974, the rate of such offenses was 2,160 per 100,000 persons, as compared to the national average of 4,822. Recent major crime statistics for Grand Forks indicate a rate of about 40 crimes per 1,000 persons. Similar data indicate a rate of about 76 crimes per 1,000 persons for East Grand Forks.

Of the seven major crime categories shown in Table 29, assaults and burglaries have shown the largest increase. Non-firearm assaults in Grand Forks accounted for 84 percent of all city assaults and increased 42 percent over 1974. Assaults in East Grand Forks increased 69 percent during the same 1-year period. Burglaries in both urban centers increased dramatically, with 1-year increases of 102 and 111 percent, respectively, in Grand Forks and East Grand Forks. A graphic display of major crime incidence for Grand Forks and East Grand Forks is shown on Plate 14.

TABLE 29

MAJOR CRIMES

GRAND FORKS AND EAST GRAND FORKS

Classification	Grand Forks 1974	Grand Forks 1975	East Grand Forks 1974	East Grand Forks 1975
Criminal Homicide	0	2	1	0
Forcible Rape	7	9	0	3
Assault	109	155	26	44
Robbery	10	14	2	1
Burglary	208	420	66	139
Auto Theft	112	111	32	32
Other Theft	1,676	1,642	402	421
	2,122	2,353	529	640

Sources: References 168, 169

GEOGRAPHIC DISTRIBUTION

HOUSING AND PROPERTY VALUE

As in other metropolitan areas of the nation, housing growth in the study area is influenced by the available money supply, income, employment and various other factors. The development and continued growth of the Grand Forks Air Base and the University have markedly influenced housing demands in the area. Much of the 57 percent population growth in Emerado between 1960 and 1970 is apparently due to the growth in Base population, and results in increased demand for area housing. In-migration from surrounding rural areas between 1960 and 1970 resulted in further strains on housing capability in the urbanized portion of the study area. Annual residential building permits issued in Grand Forks increased from 58 in 1960 to 159 in 1975.

The total number of housing units has increased in all portions of the study area except Polk County, excluding East Grand Forks, between 1960 and 1970. A noticeable trend in area housing is the shift from owner-occupied units to renter-occupied units. The principal reason for this trend is that housing costs are increasing faster than the home purchasing power of young adults who would normally be buying single-family homes. As an indication of this trend, renter-occupied units in Grand Forks accounted for about 40 percent of all occupied units in 1960, while in 1975, rental units accounted for 51 percent of all such units. Table 30 shows the 1960-70 growth in housing by major community and county, and the percent distribution of owner and renter-occupied units.

TABLE 30

HOUSING GROWTH

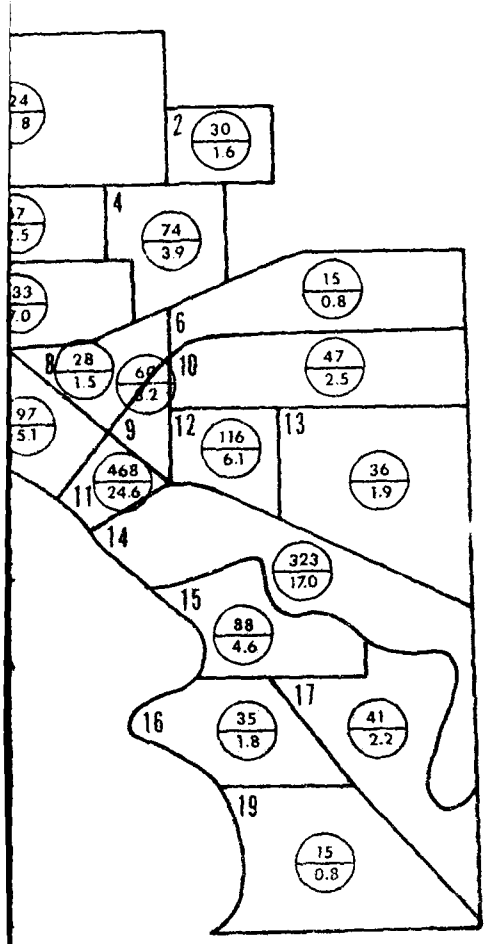
	Grand Forks		Grand Forks County		East Grand Forks		Polk County	
	1960	1970	1960	1970	1960	1970	1960	1970
All Housing Units	9,891	11,907	14,185	18,074	2,038	2,282	12,159	11,456
Occupied Units - Year Round	9,369	11,344	12,990	16,975	1,915	2,200	10,335	10,502
Owner Occupied	5,323	6,017	7,759	8,656	1,300	1,468	7,706	7,989
Renter Occupied	4,046	5,327	5,231	8,319	615	732	2,629	2,513
Vacant	522	563	1,195	1,099	123	82	1,824	954

Source: U.S. Census of Housing, North Dakota and Minnesota

Housing conditions in the area vary widely, generally according to age of the structure and relative location of the neighborhood. The major concentration of deteriorating and dilapidated housing is in the older neighborhoods, mostly of pre-World War II vintage. In Grand Forks, over 43 percent of the housing was constructed before 1940. For East Grand Forks, 37.5 percent of the housing units were built prior to 1940. The distribution of sound and deteriorating structures in the urbanized area suggests that development of the cities has followed a generally concentric pattern, expanding from the central core areas toward the outer fringe areas. It is evident that, in some areas, housing construction has occurred along arterial routes as a result of easier access to the central business districts. However, adverse environmental conditions, such as high noise levels, pollutants and high frequency of traffic movement, have likewise contributed toward deterioration of these structures. Results of the 1960 U.S. census and a 1967 local housing conditions survey in Grand Forks are presented in Table 31. The 1967 survey was only a "windshield" survey and did not include inspection of the building interiors. Housing values (1970 census) by enumeration (census) district are tabulated in Table 32 and shown graphically on Plates 15 and 16.

GRAND FORKS

PRESENTLY NOT A



Grand Forks /
URBAN WATER

REPORTED CRIMES IN THE GRA
EAST GRAND FORKS URBAN A

14 EAST GRAND FORKS REPORT

323 / 17.0 NUMBER OF COMPLAINTS PEI
PERCENTAGE OF TOTAL COM
IN EAST GRAND FORKS

SOURCE: REFERENCES 168,169.

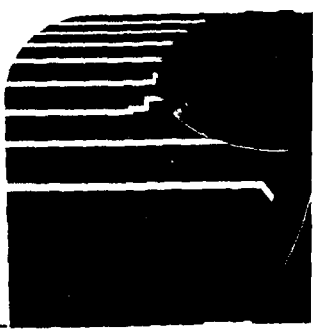


TABLE 31

HOUSING CONDITIONS - GRAND FORK

	1960 No.	%	1967
Total Units	9,891		9,2
Sound Units	8,334	84.2	6,5
Deteriorating Units	1,263	12.8	2,2
Delapidated Units	294	3.0	5(

* 1967 Survey included no trailers or 1-room units

TABLE 32

HOUSING VALUE

East Grand Forks & Adjacent Areas

Enumeration District	Under $10,000		$10,000-$24,999	
	#	%	#	%
16	96	100.0	0	0.0
17	79	42.0	109	58.0
18	5	2.9	158	93.5
19	5	100.0	0	0.0
20	67	41.1	82	50.3
21	16	27.6	38	65.5
22	14	13.5	86	82.7
24	14	100.0	0	0.0
25	0	0.0	114	81.4
26	0	0.0	127	73.0
27	54	27.8	119	61.3
15	0	0.0	14	45.2
29	11	28.2	28	71.8
28	9	12.2	65	87.8
14	70	100.0	0	0.0

TABLE 32 CON'T

HOUSING VALUE

Grand Forks Area

Enumeration District	Under $10,000		$10,000-$24,999		$25,000 & Over	
	#	%	#	%	#	%
32	0	0.0	201	88.2	27	11.8
34	10	14.3	60	85.7	0	0.0
35	62	40.8	86	56.6	4	2.6
36	89	60.5	58	39.5	0	0.0
37	79	76.7	24	23.3	0	0.0
38A	0	0.0	25	100.0	0	0.0
38B	5	4.1	94	77.7	22	18.2
40	0	0.0	9	23.7	29	76.3
41A	*					
41B	0	0.0	30	38.5	48	61.5
42	0	0.0	25	73.5	9	26.5
43	9	3.4	248	93.2	9	3.4
44	18	47.4	20	52.6	0	0.0
45	88	65.7	46	34.3	0	0.0
46	58	38.7	92	61.3	0	0.0
47	23	21.7	78	73.6	5	4.7
48	48	67.6	23	32.4	0	0.0
49	*					
50	11	16.2	47	69.1	10	14.7
51	16	39.0	20	48.8	5	12.2
52	38	16.3	150	64.4	45	19.3
53	10	5.6	149	83.2	20	11.2
54	4	4.2	37	38.1	56	57.7
55	0	0.0	0	0.0	62	100.0
56	65	61.9	40	38.1	0	0.0
57	44	28.8	109	71.2	0	0.0
58	41	31.3	90	68.7	0	0.0
59	20	14.6	117	85.4	0	0.0

TABLE 32 CON'T

HOUSING VALUE

Grand Forks Area

Enumeration District	Under $10,000		$10,000-$24,999		$25,000 & Over	
	#	%	#	%	#	%
60	0	0.0	41	73.2	15	26.8
61	24	14.1	137	80.6	9	5.3
62A	0	0.0	50	100.0	0	0.0
62B	0	0.0	26	100.0	0	0.0
63A	0	0.0	116	88.5	15	11.5
63B	5	2.9	156	90.7	11	6.4
64	20	6.7	216	72.2	63	21.1
65	0	0.0	166	67.5	80	32.5
66A	0	0.0	78	70.9	32	29.1
66B	0	0.0	0	0.0	31	100.0
66C	0	0.0	55	44.0	70	56.0
67	0	0.0	156	71.0	64	29.0
68	0	0.0	134	46.9	152	53.1
69	*					
70A	*					
70B	0	0.0	24	44.4	30	55.6
11	*					
12	30	66.7	10	33.3	0	0.0
13	*					
14	30	39.0	47	61.0	0	0.0
01	48	70.6	20	29.4	0	0.0
03	*					
04	*					
05	*					
27	37	53.6	32	46.4	0	0.0
29	*					
30	*					

Count of Owner Occupied Units by Value

Property valuations in Grand Forks have been steadily increasing in recent years, due to upgrading, additions and replacements of older structures. Assessed valuations in Grand Forks have increased from about $41.1 million in 1960 to $66.5 million in 1975. The 1975 value would be larger were it not that most personal property was exempted from taxation in 1970. Total 1975 market value of Grand Forks property was approximately $369.7 million, as shown in Table 33.

TABLE 33

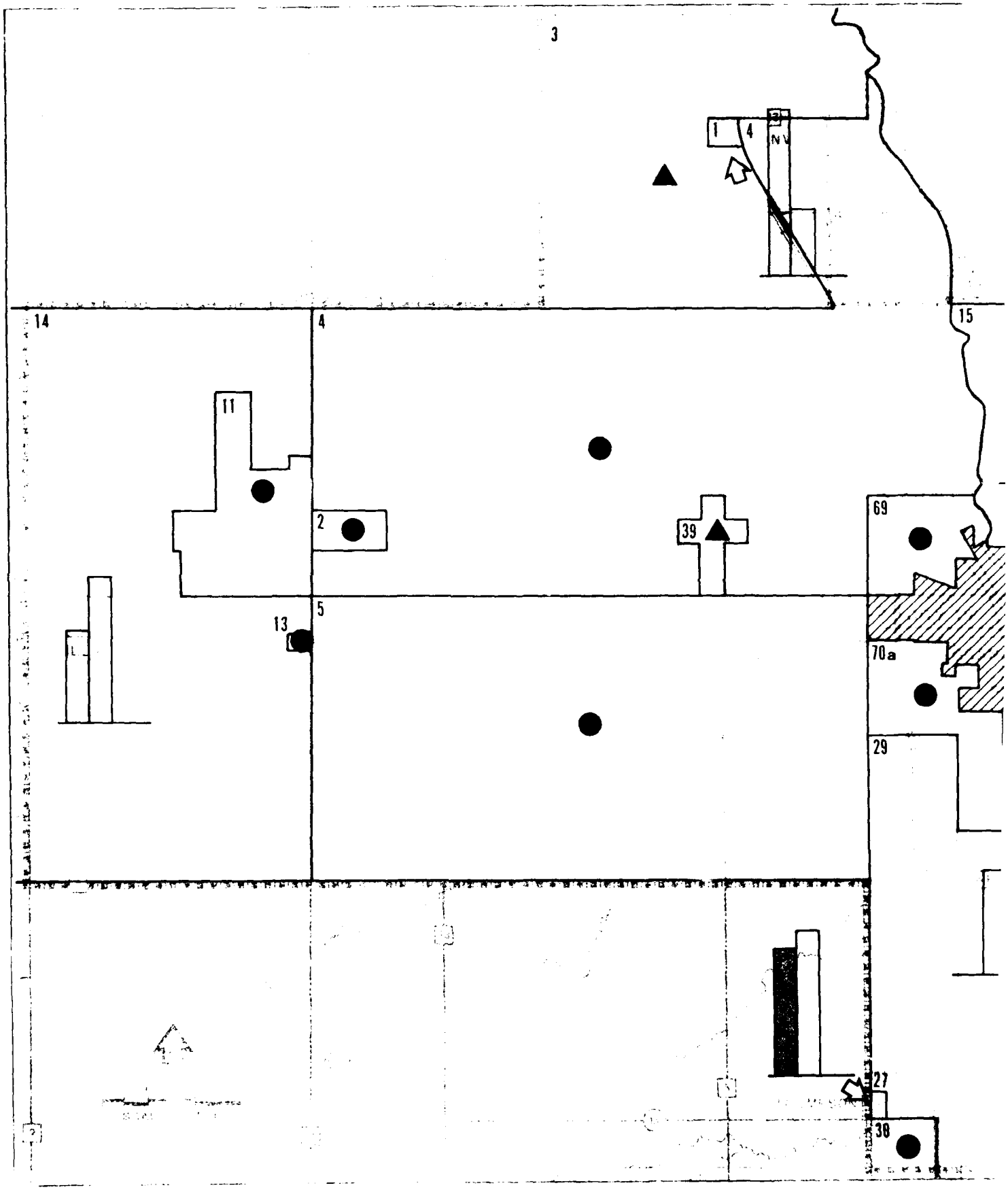
ESTIMATED MARKET VALUE
GRAND FORKS

Year	Market Value
1950	$ 90,923,200
1960	152,412,300
1965	198,159,299
1970	206,476,100*
1971	223,273,300
1972	232,484,400
1973	261,520,009
1974	279,894,130
1975	369,699,000

* All personal property exempted from taxation beginning 1970

Source: Grand Forks Industrial Development Commission

East Grand Forks has experienced a corresponding increase in property valuation. Total taxable property value increased from $3.4 million in 1970 to approximately $15.8 million in 1975.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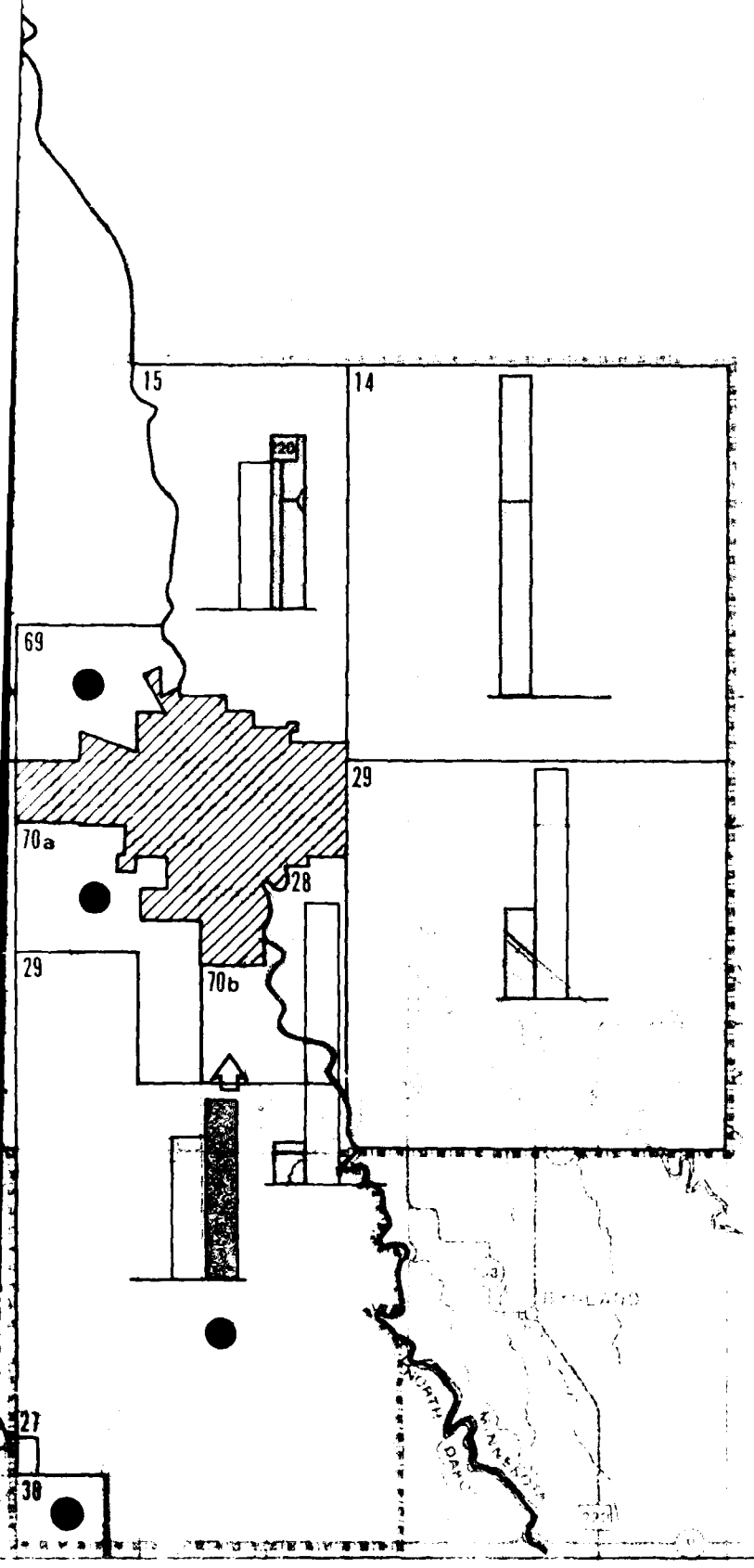


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

HOUSING VALUES
FOR HOMES IN RURAL AREAS

PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT

NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES GIVEN IN TABLE 32

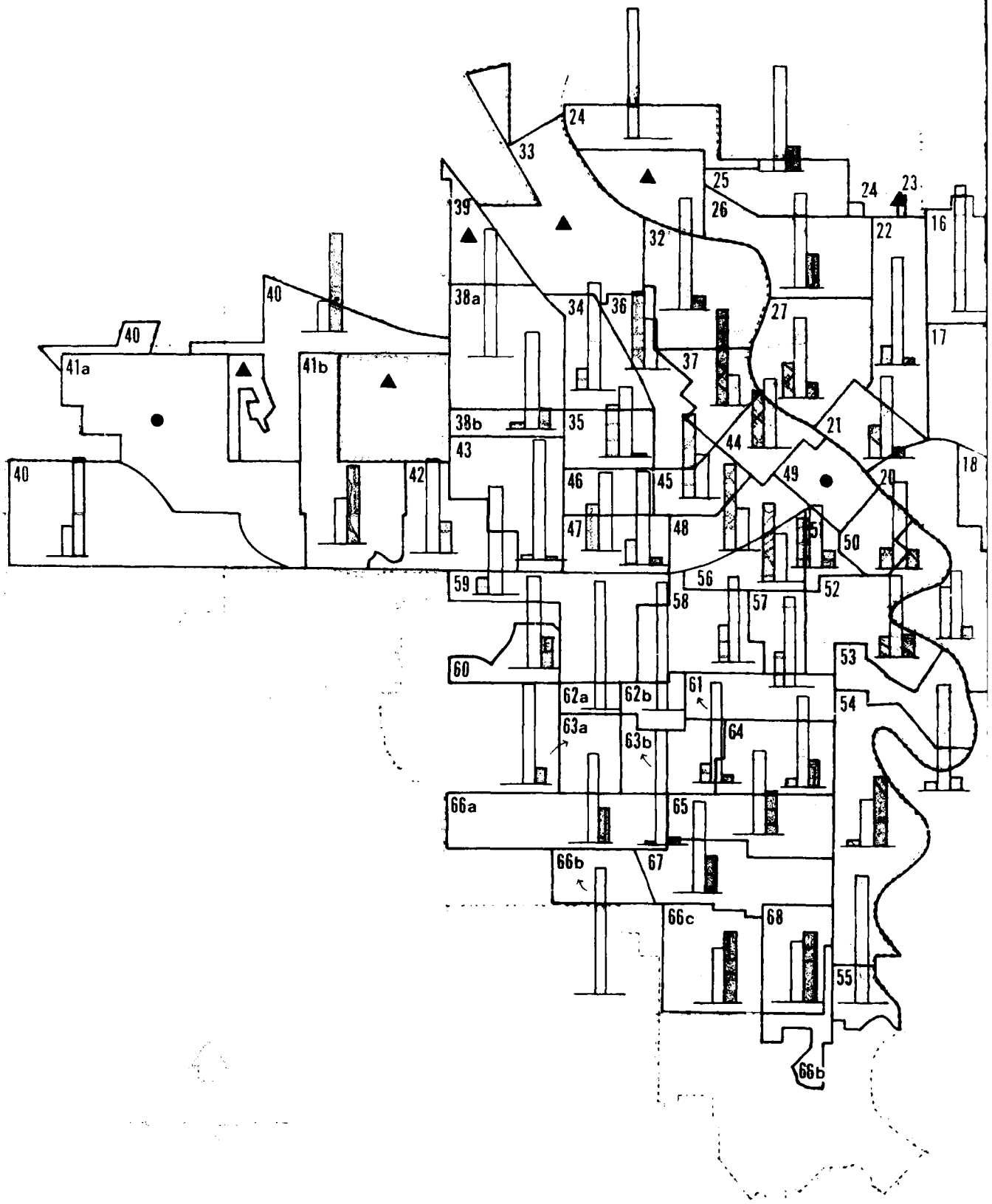
● DATA WITHHELD

▲ DATA NOT AVAILABLE

HOUSING VALUE FOR THE GRAND FORKS - EAST GRAND FORKS AREA PRESENTED ON PLATE 16

SOURCE: REFERENCE 156.

PLATE 15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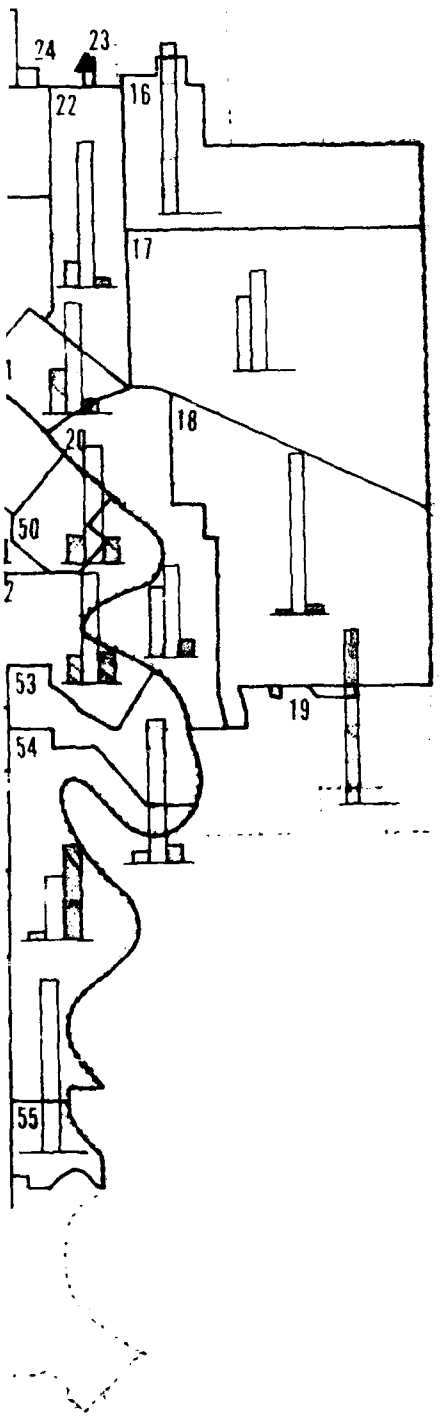
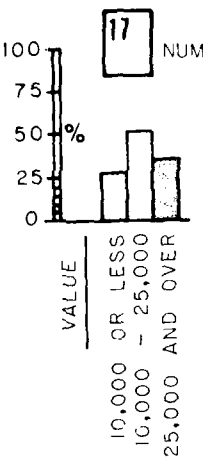


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

HOUSING VALUES
FOR HOMES IN THE GRAND FORKS - EAST GRAND FORKS URBAN AREA

PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT



NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES GIVEN IN TABLE 32

● DATA WITHHELD
▲ DATA NOT AVAILABLE

HOUSING VALUE FOR RURAL AREAS OUTSIDE GRAND FORKS - EAST GRAND FORKS PRESENTED ON PLATE 15

SOURCE: REFERENCE 156.

PLATE 16

Land values have also increased significantly in the study area. Average 1976 Grand Forks city lot prices ranged from about $5,500 for a 90 x 100 foot lot to around $7,000 for a 150 x 200 foot lot. Agricultural land values in North Dakota have increased from an average of $29 per acre in 1950 to $243 per acre in 1976, as shown in Table 34. Value per farm has also increased markedly during this same period, as shown in Table 35. In comparison, agricultural land values in the more fertile Grand Forks County area increased from $124 per acre in 1964 to $305 in 1974, as shown on Table 34.

TABLE 34

AGRICULTURAL LAND VALUES

	NORTH DAKOTA		MINNESOTA	
Year	State	Grand Forks County	Polk County	Red River Valley Minnesota
1950	$ 29	---	---	---
1960	53	---	$ 112*	---
1964	64	$ 124	139	---
1969	91	155	154	---
1974	151	305	291	$ 359
1975	---	---	---	535
1976	243	---	---	---

* 1959

Source: References 24, 104, 105, 120, 149, 153

TABLE 35

AVERAGE FARM VALUE

	NORTH DAKOTA		MINNESOTA	
Year	State	Grand Forks County	Polk County	State
1959	$ 38,800	$ 58,059	$ 47,357	$ 33,000
1964	56,000	75,344	67,245	39,075
1969	83,800	105,816	72,785	58,714
1973	110,700	---	---	---
1974	152,700	225,409	153,987	117,353
1975	211,600	---	---	---

Source: References 104, 105

KEY REFERENCES

Bureau of the Census, **General Housing Characteristics - Minnesota, 1970**

Bureau of the Census, **General Housing Characteristics - North Dakota, 1970**

Wehrman, Chapman Associates, Inc., **Neighborhood Analysis Plan - City of Grand Forks,** Minneapolis, Minn., 1968

Christianson, R. and Raup, P.M., **The Minnesota Rural Real Estate Market in 1975,** Department of Agriculture and Applied Economics, University of Minnesota, January 1976

North Dakota League of Cities, **1974 Taxable Valuation and Tax Levies in North Dakota Cities,** Special Bulletin No. 47, Bismarck, 1975

Bureau of the Census, **Detailed Housing Characteristics - Minnesota, 1970**

Bureau of the Census, **Detailed Housing Characteristics - North Dakota, 1970**

LAND USE AND ZONING

Land use within the urbanized Grand Forks-East Grand Forks area is quite varied but predominantly agricultural outside of the two communities. Typical land uses within the urbanized area include residential, industrial, commercial, recreational, public buildings and grounds, and limited fringe forest areas along the Red River of the North and Red Lake Rivers. An approximate indication of urban land use, expressed as percentages of total land use, is given in Table 36. As shown on Plate 17, the major urbanized areas are the cities of Grand Forks and East Grand Forks. Lesser areas of urban development include Manvel, Thompson and Emerado, all of which are in Grand Forks County, as shown on Plate 17. A tabulation of land use in Polk and Grand Forks Counties is given in Table 37.

Rural land use is predominantly agricultural or related activities, with transportation uses a distant second. Other than the townships adjacent to the two cities, and Mekinock and Blooming Townships containing the U.S. Air Base, agricultural and related uses account for over 97 percent of total land use. Significant Federal and State lands in Mekinock (Air Base and University lands) and Blooming (National Wildlife Refuge) Townships account for 24 and 7.5 percent of the individual township land use, respectively. Other rural land uses, as shown on Plate 17, include sand and gravel mining, wildlife management areas, transportation, airports, transportation and utility networks and sewage disposal ponds.

Urban growth in the urbanized Grand Forks area appears to be influenced by the location of major thoroughfares, major rivers and Grand Forks Air Force Base. Recent completion of Interstate Highway 29 has given impetus to westward and southward expansion. Other major areas of expansion include the U.S. Hghway 2 corridor west of the city; along U.S. Highway 81 both north and south of town; and southeastward along Belmont Road. Residential growth is primarily along Belmont Road and in the western and southwestern fringe areas. An indication of Grand Forks' urban expansion is the continued annexations by the city, as shown in Table 38.

TABLE 36

LAND USE - GRAND FORKS AND EAST GRAND FORKS

Category	Percent of Total	
	Grand Forks[1]	East Grand Forks
Residential	29.5	26.6
Commercial	5.2	1.8
Industrial	25.9	16.0
Public/Quasi-Public	12.2	11.8
Agricultural	0.0	0.0
Transportation & Utilities & Other	27.2	43.8
	100.0	100.0

1. Percent of developed city lands

Source: 1965 Grand Forks Urban Area Transportation Study and
1963 East Grand Forks Land Use Maps

TABLE 37

LAND USE BY COUNTY

	Grand Forks County (x 00^ acres)	Polk County (x 000 acres)
Total Land Area (mi^2)	1.44	2.01
Cropland	750.7	1018.6
Pasture and Range	75.5	32.9
Forest	23.2	91.8
Other	24.1	88.3
Non-Inventoried	46.7	56.0

Source: Reference 104, 119

AD-A141 958 GRAND FORKS - EAST GRAND FORKS URBAN WATER RESOURCES STUDY SOCIAL AND ENVIRONMENTAL INVENTORY(U) CORPS OF ENGINEERS ST PAUL MN ST PAUL DISTRICT 1979 3/4

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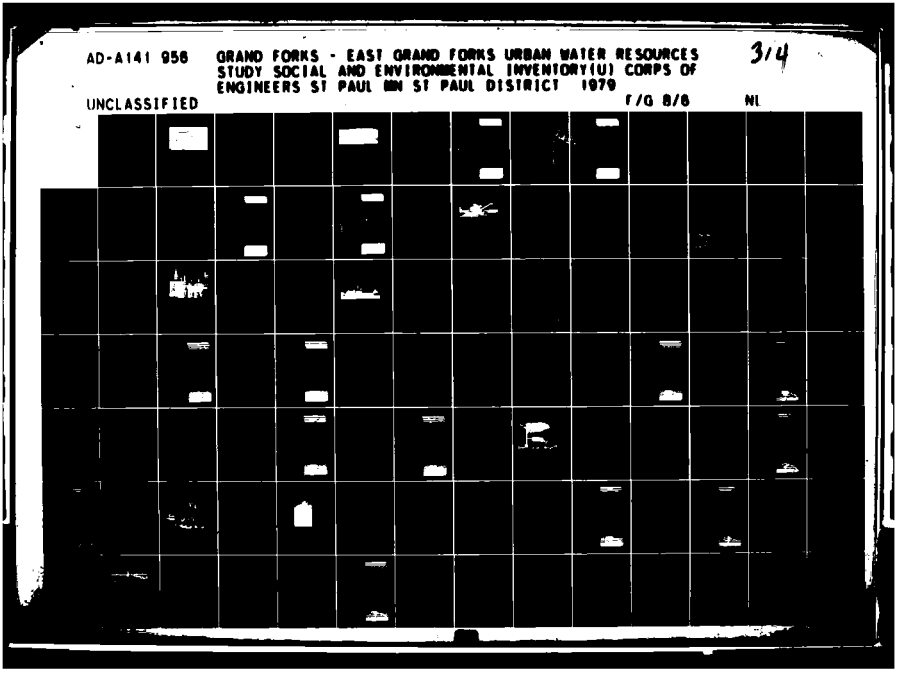
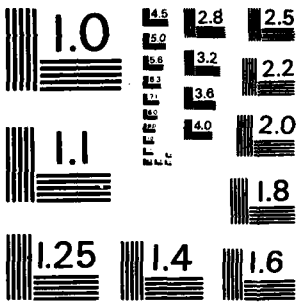




MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS - 1963 - A

Two principal areas of urban expansion outside Grand Forks are Emerado and Thompson. New housing developments being constructed on former agricultural lands are to meet Air Base and Grand Forks commuter needs. As an illustration of this growth, Thompson has increased in land area by almost 100 percent since 1970. About 44.5 percent of corporate lands, or 109 acres, in Thompson are presently in agricultural or vacant land use.

Urbanized land use in East Grand Forks is also expanding, primarily at the expense of agricultural and vacant lands. Continued residential development is concentrated primarily in the northwest and southeast sections of the community, as shown on Plate 17. Commercial development has expanded from the central business district northward along Trunk Highway 220 and along the U.S. 2 bypass. Industrial growth is occurring mostly in the eastern portion of the city.

TABLE 38

GRAND FORKS ANNEXATIONS - SQUARE MILES

Year	Area Annexed	Total Area
1938		3.67
1946-49	0.20	3.87
1951-59	1.81	5.68
1960-69	3.53	9.21
1970-73	1.05	10.26
1974-75	1.64	11.90
1976	0.30	12.20*

* Through 4/15/76

Source: Reference 24

Recreation land uses are very significant in the study area, and are concentrated primarily in the Grand Forks-East Grand Forks urbanized area. Golf courses and the city park and recreation area systems are the predominant recreational land uses, and presently account for about 350 and 164 acres in Grand Forks and East Grand Forks, respectively. Recreational land use needs will grow with expanding residential land use, and are presently accommodated in Grand Forks by required recreational land area contributions to the city in all new areas of development brought into the city. East Grand Forks is expected to enact similar land development provisions in the near future. Recreational land use and related activities are further discussed in the section of this report on Recreation.

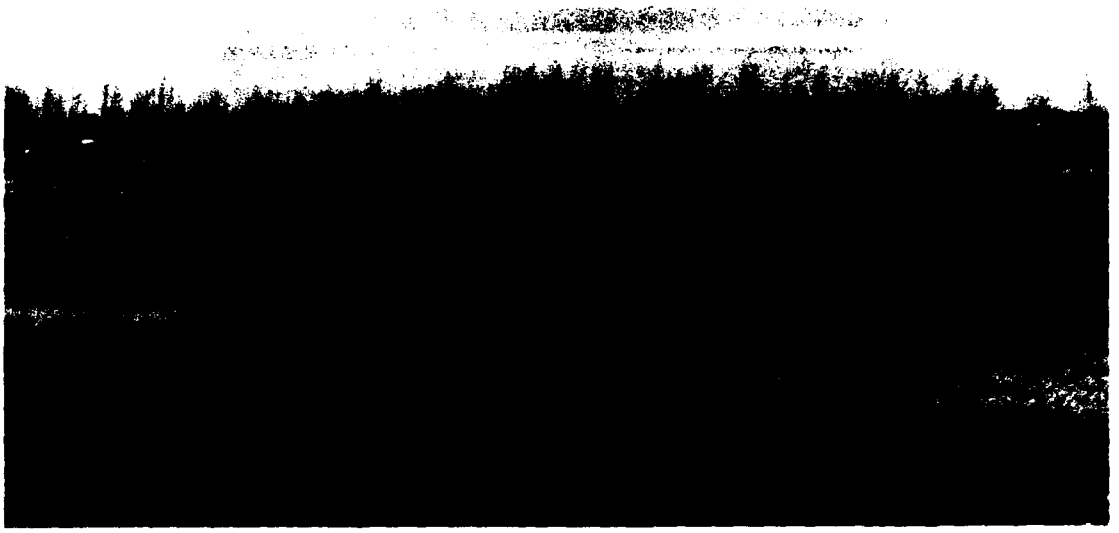
Public and quasi-public land uses are fairly well dispersed throughout the area. The principal urbanized area public and semipublic land uses include Federal, State, County and local office buildings, primarily in the central business districts; the University of North Dakota complex; city park and recreation lands; County Fairgrounds in Grand Forks; golf courses; and school grounds. Other similar land uses include the North Dakota State Highway property in Grand Forks, the Pioneer museum area, and several cemeteries. Rural public and semipublic land uses include the Grand Forks Air Force Base; University-owned land in Mekinock Township; the Kellys Slough National Wildlife Refuge; community sewage lagoons; State game management areas; and park, recreation and school areas in the smaller communities. A summary of public land ownership in Grand Forks County is given in Table 39.

TABLE 39

PUBLIC LAND OWNERSHIP - GRAND FORKS COUNTY

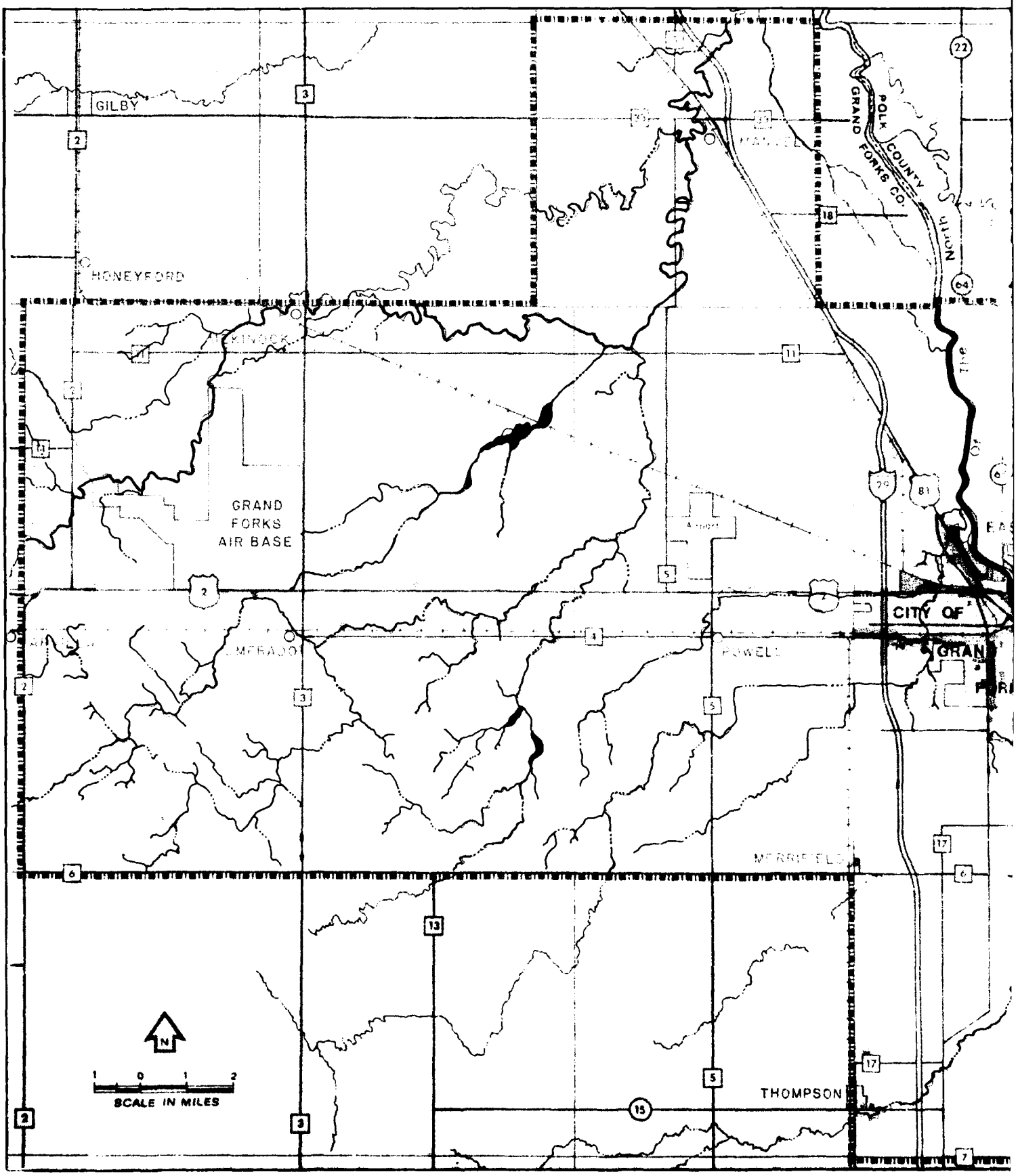
Agency	Acres
North Dakota State Land Department	2,233.8
North Dakota Game and Fish Department	2,461.84
U.S. Fish and Wildlife Service	
Fee Title	3,798.7
Easements - Leases	867.0
U.S. Department of Defense	5,341.7
Grand Forks County	NA*
State Board of Higher Education	NA*

* Data not available



Principal environmental and natural land use areas in the study area include the 2,538-acre Kellys Slough National Wildlife Refuge; the University of North Dakota's 602-acre parcel of former Grand Forks Air Base property and approximately 800-acre Oakville Prairie unit; the 560-acre Mekinock waterfowl production area; the 336-acre Turtle River waterfowl production area; and the 160-acre Penden waterfowl production area. Other environmental use areas include English Coulee, the Red River of the North floodplain at Grand Forks, and natural areas within the Grand Forks and East Grand Forks park system.

Both of the University properties include field stations for wildlife habitat studies by the Biology Department. English Coulee has at times been utilized by the University's Biology Department for pollution, water level effect and other environmental studies. Birding trips are carried out at the Kellys Slough Wildlife Refuge. The reach of the Red River of the North between the Sorlie and Kennedy Memorial Bridges is utilized by Central High School as a nature study area.


GILBY
HONEYFORD
KINDRED
GRAND
FORKS
AIR BASE
EMERADO
POWELL
MERRIFIELD
THOMPSON
CITY OF
GRAN
POLK COUNTY
GRAND FORKS CO.
NORTH
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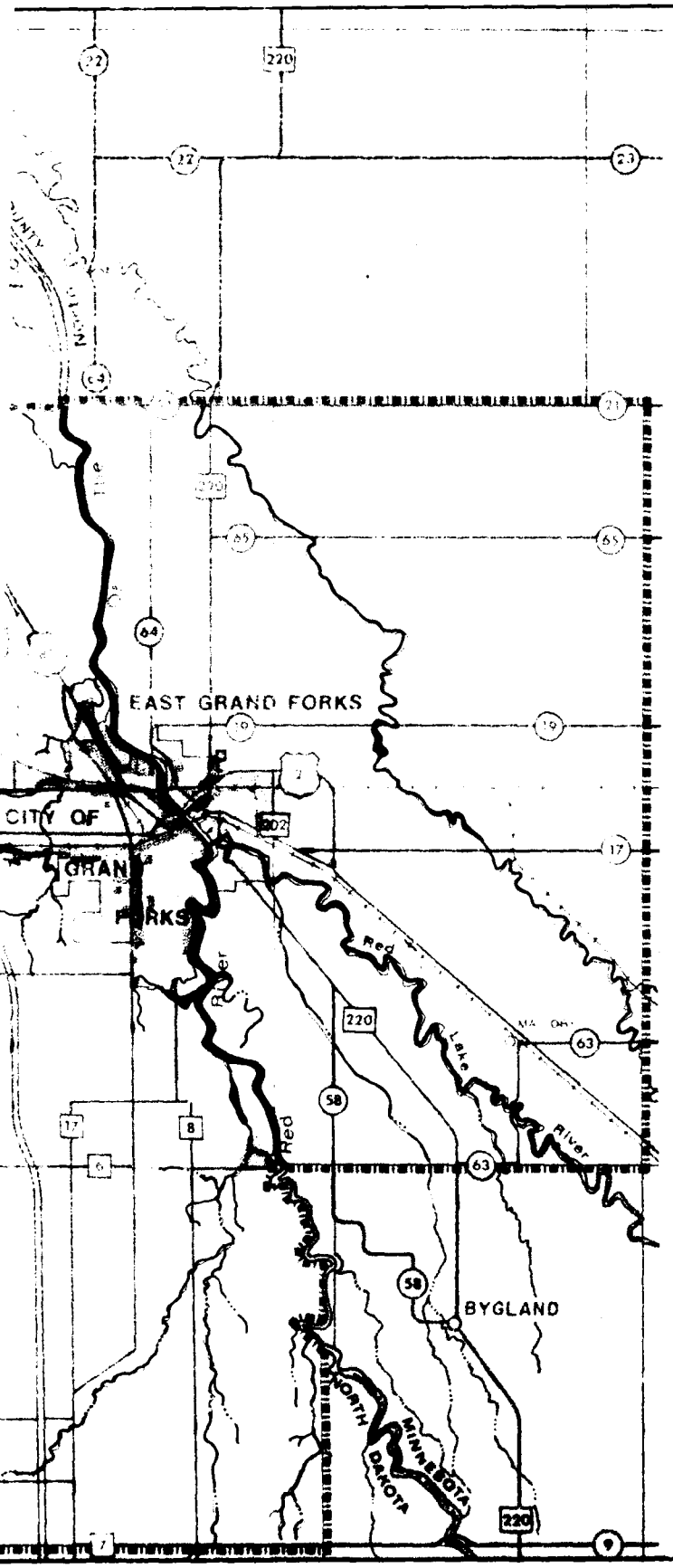
SCALE IN MILES

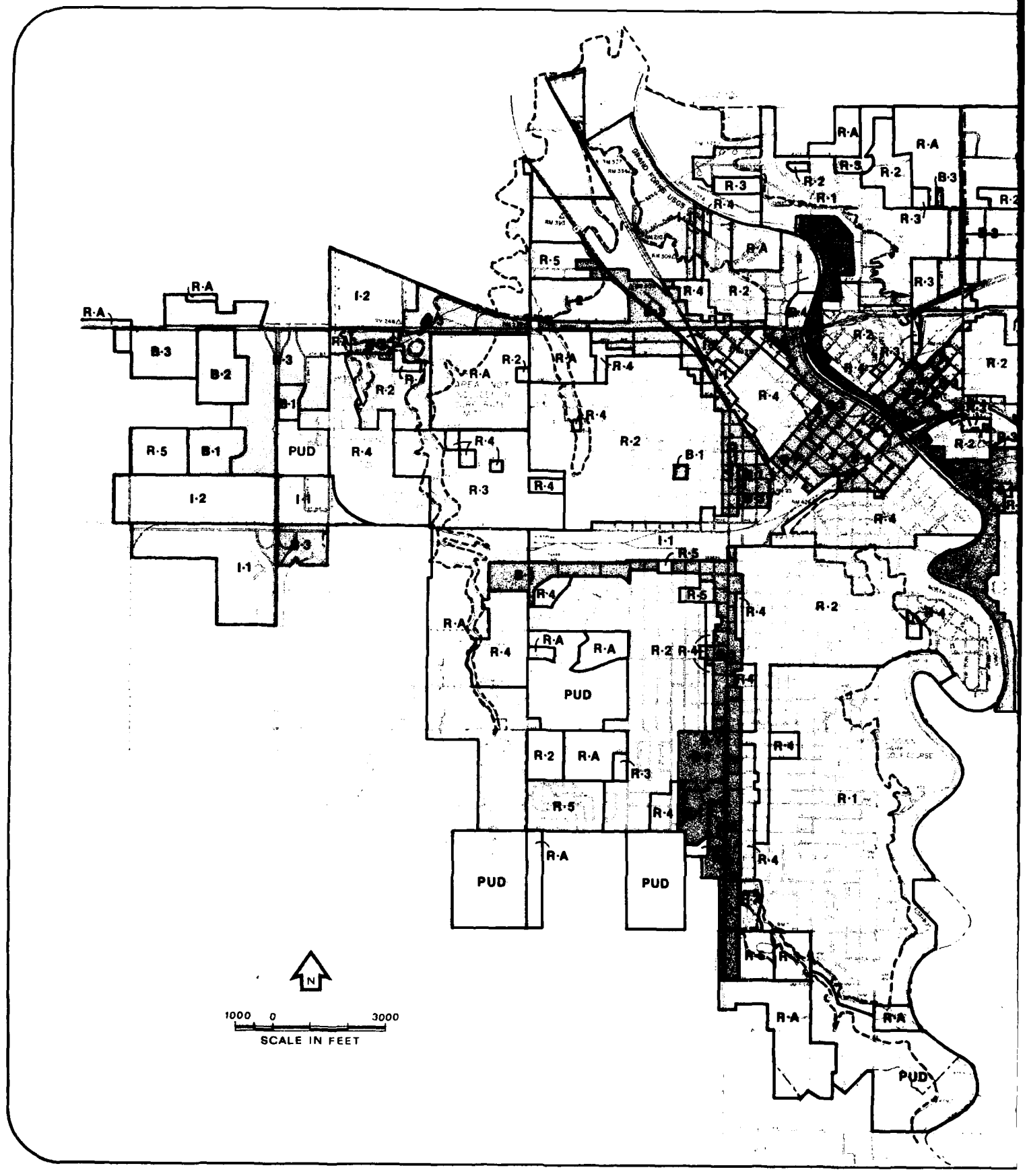


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

- RESIDENTIAL
- RECREATIONAL
- COMMERCIAL
- PUBLIC, SEMI-PUBLIC
- INDUSTRIAL
- AGRICULTURAL OR OPEN LANDS

SOURCE: REFERENCES 40,48,111,113.

PLATE 17


R-A
B-3
B-2
B-1
I-2
I-1
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R-4
R-3
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R-1
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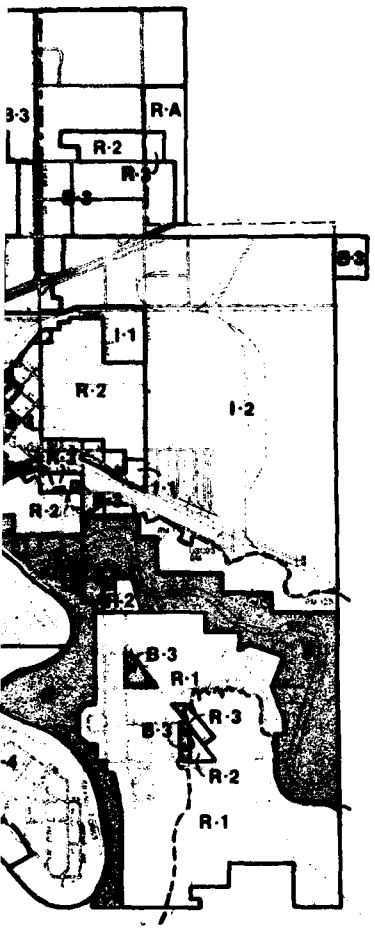
1000 0 3000
SCALE IN FEET



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

ZONING DISTRICTS

R-A	AGRICULTURAL RESIDENTIAL
R-1	SINGLE FAMILY RESIDENTIAL
R-2	ONE & TWO FAMILY RESIDENTIAL
R-3	ONE & TWO FAMILY AND MULTIPLE FAMILY RESIDENTIAL
R-4	MULTIPLE FAMILY RESIDENTIAL
R-5	MOBILE HOMES
B-1	LIMITED BUSINESS
B-2	SHOPPING CENTER BUSINESS
B-3	SERVICE BUSINESS
B-4	GENERAL BUSINESS
I-1	LIMITED INDUSTRIAL
I-2	GENERAL INDUSTRIAL
	FLOODWAY
PUD	PLANNED UNIT DEVELOPMENT
-------	100-YEAR FLOOD PLAIN LINE

SOURCE: REFERENCES 116,117,118.

PLATE 18

Zoning regulations are in effect for both Grand Forks and East Grand Forks. A zoning resolution for Grand Forks County is pending. A map of urban zoning for Grand Forks and East Grand Forks is shown on Plate 18.

KEY REFERENCES

Community Planning and Design Associates, Inc., **Comprehensive Guide Plan - East Grand Forks,** Minneapolis, Minn., 1965

Wehrman, Chapman Associates, Inc., **Plan For Future Growth, City of Grand Forks, North Dakota,** Minneapolis, Minn., 1969

Wehrman, Chapman Associates, Inc., **Polk County Land Use Plan,** January 1970

Floan and Sanders, Inc., **Official Zoning Districts - East Grand Forks,** Map, Revised March 1975

Orthmeyer, F., **Zoning Map, Parts I and II,** City Engineers Office, Grand Forks, August 1975

GOVERNMENTAL ORGANIZATION

POLITICAL STRUCTURE

The study area is served by several levels of government, ranging from the national political structure down through State, regional, county and local governing bodies. All of these forms of government have varied taxing authorities, which complement, and in some instances, overlap in terms of jurisdictional responsibilities and boundaries.

The Grand Forks County study area is represented on the national level by the State's U.S. Senators and Representative from the First Congressional District. The Polk County study area is similarly represented in the U.S. Senate and by the Representative of the Seventh Minnesota Congressional District.

On the State level, the Grand Forks area is represented in the North Dakota Senate by Senate District 42 and House Districts 17, 18 and 43. The East Grand Forks area is similarly represented by Senate District 2A.

Regional government in the study area is provided in the North Dakota portion by the Red River Council, with offices in Grafton, North Dakota. The Northwest Regional Development Commission (Region I), with offices in Crookston, Minnesota, provides regional representation to the Polk County study area. The purpose of these commissions, consisting of representatives of county, township and municipal governments, is basically to facilitate intergovernmental cooperation and coordinate planning and development on a regional basis. The commissions also serve as a clearinghouse for review of local applications for Federal funding. These commissions have authorized taxing authorities to finance their activities. However, some commission activities are financed by grants from various Federal and State sources.

Grand Forks County was created by the 10th session of the Territorial Legislature in 1873, and organized the following year. County governmental duties are performed by an elected board of six county commissioners and other officials, including the County Treasurer, Sheriff, Clerk of Court, Register of Deeds, State's Attorney, County Judge, Superintendent of Schools, Auditor, Superintendent of Highways, County Planner (part-time only) and County Agricultural Extension Agent. Appointed boards and committees such as the County Water Management Board are formed as required to resolve various issues. The Polk County political structure, similarly, consists of elected commissioners and both elected and appointed officials. Polk County was created in 1858, and subsequently divided four times before reaching its present size.

The original plat of the Grand Forks townsite was filed in 187[illegible]e village was organized in 1878, followed by incorporation in 1881. Municipal government is provided by a mayor and and a 14-ward alderman council elected to 4-year terms of office. City administration is accomplished by various function-oriented departments, the most prominent including the Departments of Administration and Public Works, Police and Fire Departments, Health Department, Department of Housing and Community Development and the municipal court and public school systems. City park and recreational planning and development are under the jurisdiction of the City Park Board. Community planning activities are accomplished by the city planner in concert with a 15-member planning commission. Sources of revenue for financing city government operations include the ad valorem tax, other miscellaneous taxes, and utility assessments and revenues, with an average 1976 per capita General Obligation Bond debt of $12.85.

East Grand Forks is similarly served by an elected mayor-council form of government. Major governmental departments include administration, the municipal court and school systems, police and fire departments and city recreation department. Required engineering services are provided by a consultant under contract to the city. Planning services are provided by the City Planning Commission, with outside assistance as required. Primary sources of revenue for governmental operations include property taxes, various fees and miscellaneous taxes, Federal and State aid allotments, and utility assessments and revenues.

Local community governments, all in Grand Forks County, consist of a mayor and council, together with the various township boards of supervisors. The smaller communities such as Thompson, Emerado, Arvilla and Manvel provide their own administrative, police and fire protection and sewerage services. Community planning and engineering services for the Grand Forks County communities are usually provided on a continuing or as-needed basis by the regional planning council or private consultants.

TAXES

Property taxes in the Grand Forks-East Grand Forks area generally correspond to the level of services provided and intensity of use. As in other metropolitan areas, taxing authorities by the various governing agencies and school districts overlap.

In North Dakota, the primary source of revenue for support of local government is the ad valorem property tax. Nearly all personal property is exampt from taxation. The property tax is used to support schools, parks and city and county governmental operations, along with one-half of one percent to support the State Medical Center at Grand Forks.

Using the 1972-73 budget year as an example, local units of government in Grand Forks levied a total of about $6.1 million in property taxes. Of this amount, schools accounted for about 44 percent, city government 26 percent, county government 21 percent, parks and recreation 6 percent, public library 2 percent and water district 1 percent.

There is no general homestead exemption law in North Dakota. A limited exemption is available to those over 65 who have total incomes of less than $3,000 per year. Special exemptions are granted to disabled veterans, the blind and farmers. All farm buildings and improvements are totally exempt from taxation.

Although North Dakota State laws normally limit local taxing authorities, communities may, at their election, adjust or even remove such limitations, as in Grand Forks, where local voters have approved a special mill levy (tax rate in one-tenth cents) for Park Board recreational purposes. The total consolidated tax rate for Grand Forks in 1973 was 226.6 mills, which, when applied against the ratio of 11.5 percent of market value, yields an effective tax of about 2.7 percent of the property value. The same tax rate applies to all property, including income producing property. Taxable property valuations and tax rates in

property, including income producing property. Taxable property valuations and tax rates in 1974 for Grand Forks and selected smaller communities are given in Table 40. Tax levies by school district are shown on Plate 19.

The real estate tax is also an important source of community revenue in Minnesota. The tax rate for East Grand Forks is based on an assessed value equal to 43 percent of the market value. The city's 1976 tax rate was 120.62 mills and supported local schools and local county and regional government in the following proportions:

Municipal	32.0%
School District	48.4%
County	19.1%
Red Lake River Watershed District	0.4%
Region I Development Commission	0.1%

Certain personal property, such as automobiles and boats, is subject to taxation. Of the total 1976 taxable property valuation of $15,823,453 in East Grand Forks, taxable personal property was valued at $1,206,983, or about 8 percent.

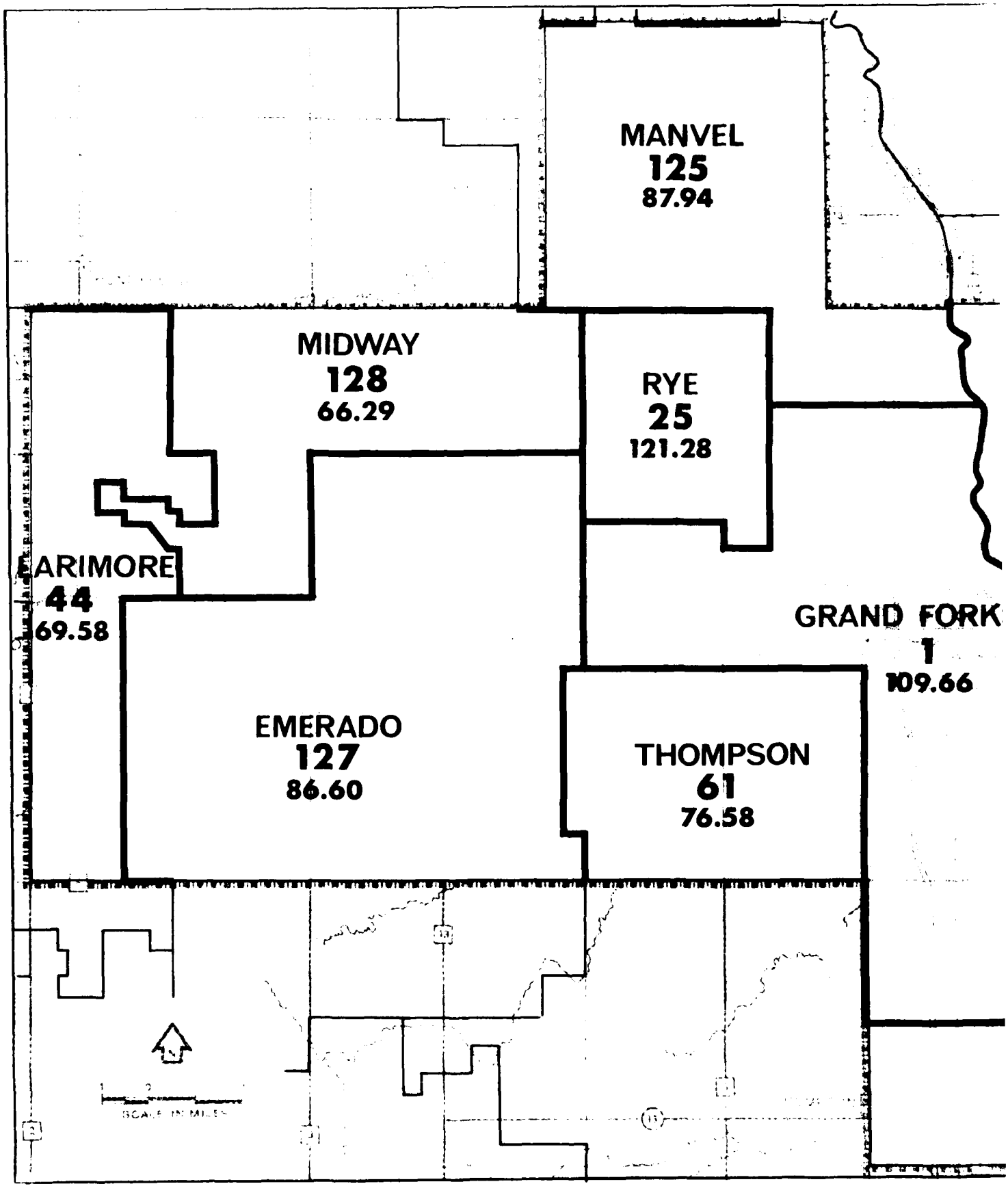
A homestead exemption up to a maximum of $325 per residence is granted in Minnesota to owner-occupied households and property owners. Agricultural property is taxed, but any farm property with 10 or more acres of cropland is taxed at a lower rate.

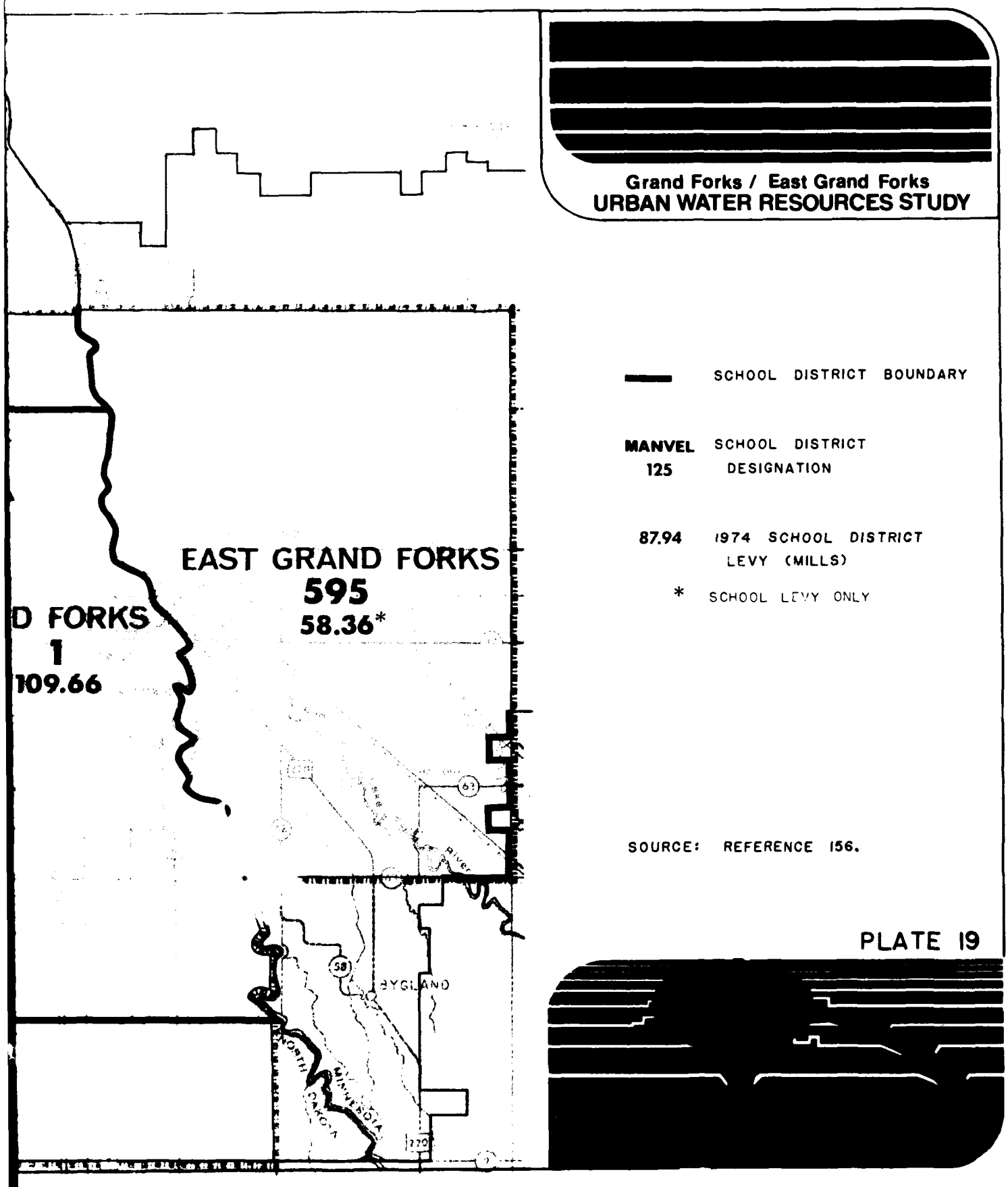
TABLE 40

PROPERTY VALUATIONS AND TAX RATES - 1974

City	1974 Taxable Valuation	1974 State & County Levy - Mills	County School Equalization	Total City Levy - Mills	Park District Levy - Mills	School District Levy - Mills	Total of all 1974 Levies - Mills
Grand Forks	$ 32,187,325	31.53	19.87	59.58	14.56	109.66	235.20
Emerado	128,367	31.53	19.87	71.36	1.17	86.60	210.53
Manvel	107,905	31.53	19.87	33.09	4.00	87.94	176.43
Thompson	207,417	31.53	19.87	52.01	---	76.58	179.99

Source: Special Bulletin No. 47, North Dakota League of Cities


MANVEL
125
87.94
MIDWAY
128
66.29
RYE
25
121.28
ARIMORE
44
69.58
GRAND FORK
1
109.66
EMERADO
127
86.60
THOMPSON
61
76.58
N
SCALE IN MILES



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

SCHOOL DISTRICT BOUNDARY

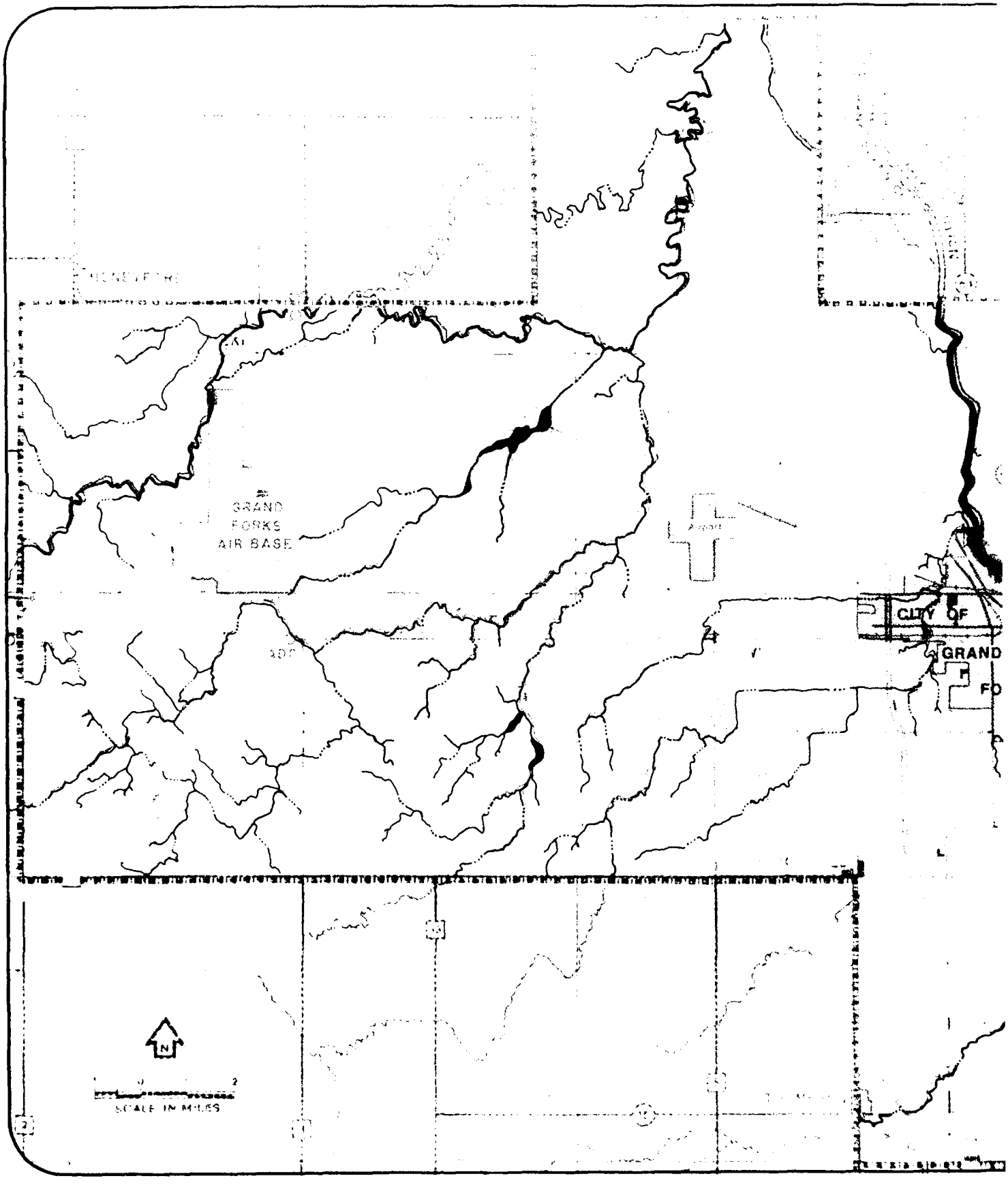
MANVEL SCHOOL DISTRICT
125 DESIGNATION

87.94 1974 SCHOOL DISTRICT LEVY (MILLS)

* SCHOOL LEVY ONLY

SOURCE: REFERENCE 156.

PLATE 19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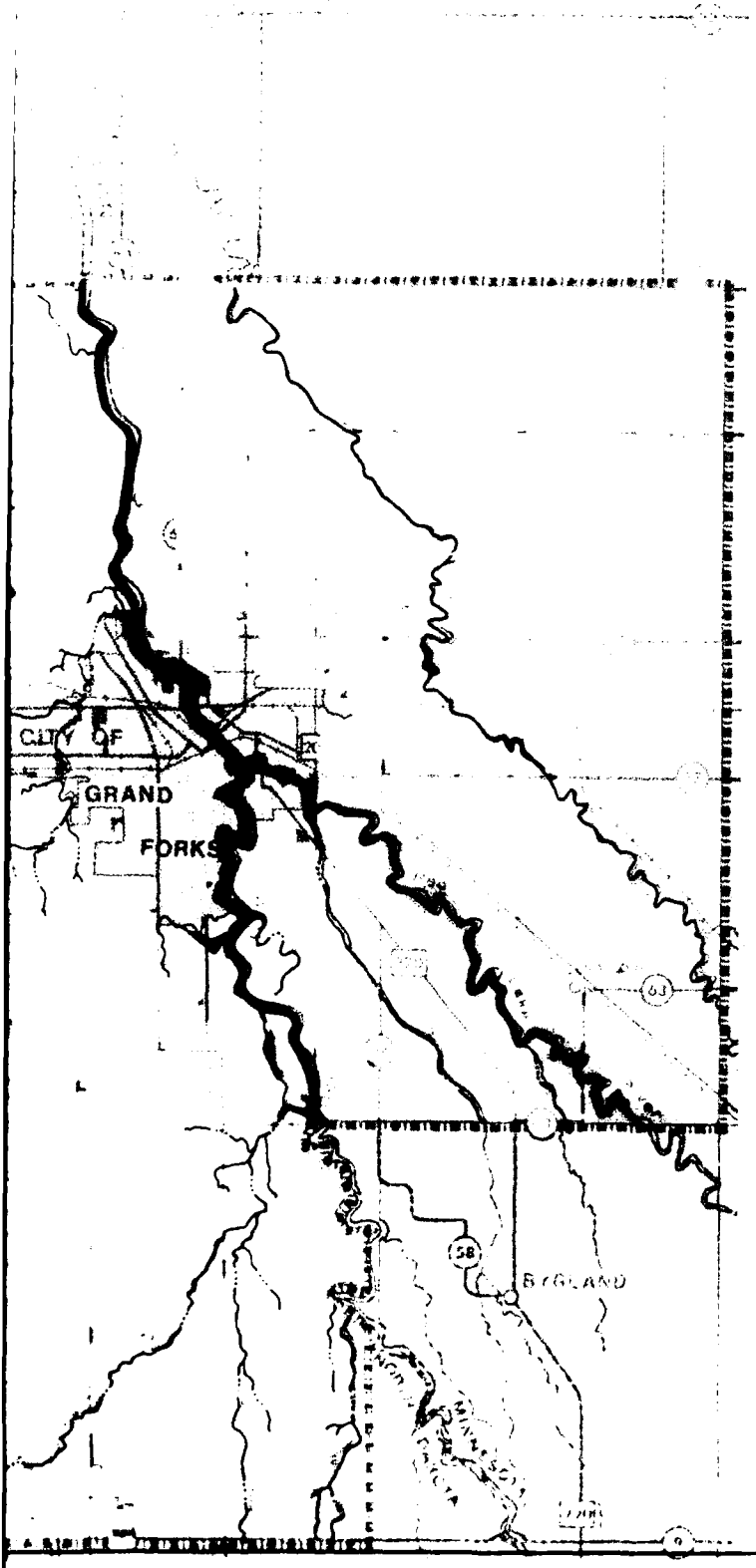
Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



- URBAN AREAS
- WOODLANDS
- CROPLANDS
- GRASS AND OPEN LANDS
- LAKES AND PONDS
- MAJOR RIVER SYSTEMS
- SECONDARY OR INTERMITTENT STREAMS

SOURCE: REFERENCES 40,48,107,108.

PLATE 20

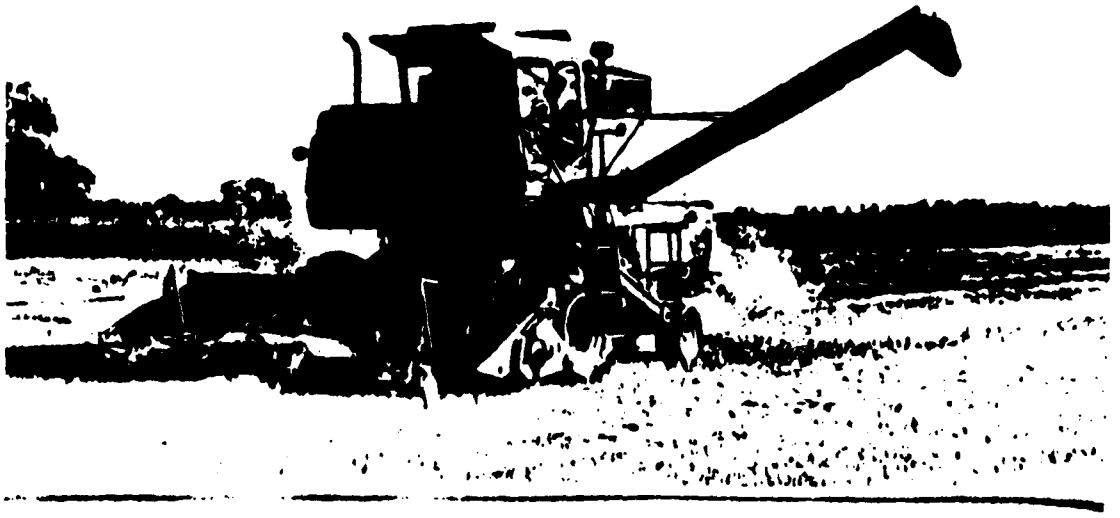
ECONOMY

AGRICULTURE

From its early subsistence forms, as practiced by the Indians and early settlers, agriculture and its related activities are still the single most important sector of the regional economy. The early settlers, who first grew corn and other vegetable products for their family needs and then corn for livestock feed and marketing, soon found that the rich valley soils were ideal for spring wheat and other small grains. Completion of the railroads into the Grand Forks area in the early 1880's provided additional impetus for agricultural growth by creating a vastly wider market area, including the Minneapolis-St. Paul area, for local farm products.

The flat former glacial lake bed makes the Red River Valley one of the nation's most productive small grain, potato and sugar beet areas. The fertile topsoil was created by countless years of decaying original prairie vegetation. The very flat topography, with maximum relief changes of about 5 feet in the study area, enables the use of large equipment and a minimum of labor on the large farms. Natural drainage in the area is only poor to fair, requiring extensive drainage works in both counties. Because of the flat land and poor natural drainage, farmlands generally suffer extensive losses due both to direct flooding and prolonged inundation of immature crops. A description of agricultural resources of the study area is shown on the Agricultural Resources Plate (Plate 20).

As with most all other areas of the nation, the study area is experiencing a continuing decline in the number of farms, with a corresponding increase in farm size. During the 5-year period from 1969 to 1974, the number of farms in Grand Forks County decreased from 1,281 to 1,172 (-8.5%), with an increase in average farm size from 683 acres to 739 acres (+8.2%). Similar data for Polk County indicate a 10.9 percent decrease in farm numbers with an 11.8 percent increase in average farm acreage.



Total land area in farms is decreasing slightly, as indicated by a 5-year decrease of 1.1 percent in Grand Forks County and a 0.2 percent decrease in Polk County. It is apparent that, for the present at least, continuing cropland losses due to urbanization are being nearly offset by use of more marginal lands and removal of windbreaks and other forest growth.

North Dakota is presently the nation's leading producer of spring wheat, including durum wheat, rye and flaxseed. Grand Forks County is the State's leading producer of barley, ranks second in wheat and potato production and third in sunflower seeds. Similarly, Minnesota is one of the nation's leading crop producers, ranking in the top 10 states for all principal crops grown in the region, except winter wheat. Within Minnesota, Polk County ranks as the leading producer of spring wheat, barley, potatoes and sugar beets. It ranks in the top 10 counties for oats, sunflower seeds, milk production, stock sheep and lambs and total hens and pullets. Agricultural production for crop year 1975 for Polk and Grand Forks Counties is tabulated in Tables 41 and 42, respectively.

TABLE 41

AGRICULTURAL PRODUCTION BY COUNTY - 1975

Polk County

	1975 Rank in State	Acres Harvested	Ave. Yield[1] per Acre	Total Production	1975 Dollar[2] Value	1971-75 5-yr. ave. prod.
Corn-Grain	—	8,300	52.0 Bu.	431,600	1,035,800	356,400
Spring Wheat (No Durum)	1	383,500	40.9 Bu.	15,680,600	61,154,300	12,095,200
Durum Wheat	--	--	--	--	--	--
Oats	8	50,100	44.4 Bu.	2,222,600	3,222,600	4,939,700
Barley	1	164,800	47.5 Bu.	7,832,800	20,756,900	7,311,100
Rye	8	3,800	25.5 Bu.	96,800	232,300	100,500
All Hay	6	75,800	2.0 Tons	149,900	7,570,000	152,700
Flaxseed	11	5,500	12.0 Bu.	66,000	432,300	85,000
Potatoes	1	20,200	175 CWT	3,535,000	15,306,550	4,468,000
Sunflower Seed	6	11,800	1193 Lbs.	14,073,000	1,491,700	18,617,000
Sugar Beets	2	59,400	14.4 Tons	855,400	34,985,900[3]	794,200
Soybeans	--	1,800	16.1 Bu.	29,000	133,400	34,900

1. Based on production
2. Using statewide seasonal average price
3. Based on 1974 prices

Source: Reference 104, 107, 105, 108

TABLE 42

AGRICULTURAL PRODUCTION BY COUNTY - 1975

Grand Forks County

	1975 Rank in State	Acres Harvested	Ave. Yield[1] per Acre	Total Production	1975 Dollar[2] Value	1971-75 5-yr. ave. prod.
Corn-Grain	--	1,000	56.0 Bu.	56,000	134,400	--
Spring Wheat (No Durum)	2	302,000	34.7 Bu.	10,640,000	42,028,000	6,774,500
Durum Wheat	--	38,900	31.6 Bu.	1,229,200	5,592,900	474,800
Oats	--	28,900	52.2 Bu.	1,507,700	1,960,000	1,875,400
Barley	1	126,000	45.5 Bu.	5,731,600	18,111,900[3]	4,757,600
Rye	--	2,000	23.0 Bu.	45,900	105,570	41,100
All Hay	--	24,400	1.9 Tons	46,200	1,686,300	--
Flaxseed	--	14,000	9.6 Bu.	133,900	863,655	206,700
Potatoes	2	31,100	168 CWT	5,442,500	23,402,800	--
Sunflower Seed	3	58,800	1040 Lbs.	61,150,000	6,622,500	--
Sugar Beets	6	11,400	13.5 Tons	153,400	5,936,600[3]	--
Soybeans	--	0	--	--	--	--

1. Based on production
2. Using statewide seasonal average price
3. Based on 1974 prices

Source: References 105, 108

The average growing season of 127 days and average annual precipitation of about 20 inches make this area ideal for the production of small grains which can tolerate drought periods. Although spring wheat and barley remain the principal crops, in recent years the Red River Valley has emerged as an important potato, sugar beet and sunflower seed producing area. In Polk County during the 1971-1975 period, the production of spring wheat increased by about 30 percent, and sugar beets by over 40 percent. Oat and flax production experienced significant declines. Corn, hay and potato production experienced erratic growth during the period. Similar data for Grand Forks County indicate 1975 spring wheat production exceeded the preceding 5-year average by about 28 percent; barley production was some 20 percent above the 5-year average; oat and flaxseed production was substantially below the 5 year average, and continuing an apparent downward trend. Typical yields for major crops in both counties for the years 1970-1975 are given in Table 43.

TABLE 43

AVERAGE CROP YIELDS

	Grand Forks County					Polk County				
Crop	1971	1972	1973	1974	1975	1971	1972	1973	1974	1975
Corn (Grain) (bu/ac)	53.0	36.0	30.0	30.0	56.0	60.0	60.0	55	40.9	52.0
All Wheat (bu/ac)	30.6	32.0	33.8	23.6	35.2	39.7	37.8	37.9	31.4	40.4
Spring Wheat[2] (bu/ac)	31.0	32.5	32.5	23.6	35.8	40	38	38	31.6	40.9
Oats (bu/ac)	48.0	54.0	51.8*	33.8	52.2	61	53	47	35.8	44.4
Rye (bu/ac)	27.0	27.0	32.0	20.5	23.0	30	21	36	28.5	25.5
Barley (bu/ac)	40.0	41.0	39.0	35.0	45.5	50	49	42	40.4	47.5
Flax (bu/ac)	11.0	13.0	9.0	8.5	9.6	12	11	12	11.6	12.0
Sunflowers (lbs/ac)	—	850	950	780	1040	—	1000	950	600	1193
All Hay (ton)	1.69	1.52	1.60	1.88	1.89	1.8	2.2	1.8	2.1	2.0
Potatoes (cwt)	155	167	141	185	175	180	185	140	190	175
Sugar Beets (tons/ac)	10.9	12.5	14.2	10.1	13.5	?	14.4	16.6	12.5	14.4
Durum Wheat (bu/ac)	27.0	25.0	23.0	23.7	31.6	--	--	--	--	--

1. Based on harvested acres
2. Excluding Durum Wheat

Source: References 107 and 108

The study area includes a modern and efficient system for the harvesting, storage and marketing of agricultural products. As an indication of modern mechanization, total agricultural employment in the two-county area declined from 5,977 in 1960 to 3,285 in 1970. Storage elevators are located both on farms and in most small communities, and are owned and managed by either private investors or farmer-owned cooperatives. The State-owned North Dakota Mill at Grand Forks provides area farmers an outlet for their milling products. An American Crystal Sugar Company sugar beet processing plant, with a capacity of approximately 8,000 tons per day, is located in East Grand Forks. 41 potato warehouses, with a total storage of over 10 million bushels, are also located in East Grand Forks.

The marketing or movement of area agricultural products is handled by a truck-rail system. As an illustration of area grain movements, of the commercially-stored grain in Grand Forks County (1974-1975), about 58 percent of the spring wheat was shipped to national or foreign export markets via Duluth-Superior Harbor, 33 percent was sent to the Minneapolis-St. Paul area, and 9 percent was moved to west coast and other destinations. For barley shipments, about 22 percent went to Duluth-Superior, 75 percent went to Minneapolis-St. Paul, and only about 3 percent was shipped to west coast ports and other areas. The high concentration of barley shipments to the Minneapolis-St. Paul area is due to demand from malting firms in that area. Of the different movements from commercial storage in Grand Forks County, about one-half the hard red spring wheat is moved by rail, as is 88 percent of the barley and 23 percent of the flax.

Over 40 percent of all economic activity in the Grand Forks-East Grand Forks area is directly related to agriculture. Total 1974 income from cash crops, livestock production, forestry and poultry production was $76,890,000 for Grand Forks County and $122,517,000 for Polk County. Approximately 2,000 persons were employed in Polk County agricultural activity in 1970, or 17 percent of total county employment. Similarly, 1,281 persons in Grand Forks County were engaged in agricultural related activities.

KEY REFERENCES

Bureau of the Census, **1974 Census of Agriculture - Minnesota,** 1976

Bureau of the Census, **1974 Census of Agriculture - North Dakota,** 1976

Grand Forks County ASCS, **1974 Crop Acres Planted in Grand Forks County,** Tabulation

Minnesota Department of Agriculture, **Minnesota Agricultural Statistics - Crop Years 1971-1975,** Crop and Livestock Reporting Service, USDA

U.S. Department of Agriculture Statistical Reporting Service and Agricultural Experiment Station, NDSU, **North Dakota Crop and Livestock Statistics - Annual Summaries for Crop Years 1971-1975,** Fargo, North Dakota

COMMERCIAL AND INDUSTRIAL ACTIVITY

The Grand Forks-East Grand Forks area has experienced continued change and growth to become the region's most important trade, service and manufacturing center. In contrast to the earliest fur trapping, sawmill, boat building and river navigation activities, present economic activity includes a wide variety of wholesale and retail trade, government and private services, and light and heavy industry. The growing economy is well illustrated by increasing sales and a more than 3-fold increase in building permit valuations, as shown in Table 44. Another major economic activity, the Grand Forks Air Force Base, contributes approximately $11,700,000 annually to the area economy.

TABLE 44

TAXABLE SALES & BUILDING PERMITS - GRAND FORKS

Year	Taxable Sales	Building Permits (Valuations)
1950	$ 46,424,000	$ 6,833,718
1960	60,492,000	4,191,857
1970	105,030,497	10,800,715
1971	113,756,542	11,631,055
1972	127,000,000	20,183,066
1973	127,523,732	22,509,953
1974	139,315,249	11,778,416
1975	189,025,013	22,628,205

Source: Grand Forks Industrial Development Commission

Wholesale trade has experienced a significant increase in the study area, both in terms of number of businesses and volume of sales. As shown in Table 45, the growth in number of wholesale businesses in Grand Forks County was about twice that of Polk County from 1963 to 1972; however, the percentage growth in sales volume was about the same in both counties. Wholesale growth patterns in the two counties, excluding the two major communities, are quite different, as indicated by a slight decrease in business numbers in Grand Forks County outside of Grand Forks, and a slower growth in sales volume. The proximity and size of Crookston and other Polk County communities have a significant influence on county business so that wholesale trade in Polk County, outside of East Grand Forks, is growing about as fast as that in East Grand Forks.

TABLE 45

WHOLESALE TRADE 1963-1972

Location	Number of Establishments 1963	1972	% Change 1963-1972	Wholesale Sales 1963 x $1000	1972 x $1000	% Change 1963-1972
Grand Forks	57	97	70.2	35,347	74,993	112.2
Grand Forks County	105	142	35.2	56,581	106,914	89.0
Remaining Grand Forks County	48	45	-6.2	21,234	31,921	50.3
East Grand Forks	21	28	33.3	12,952	27,859	115.1
Polk County	105	127	21.0	36,781	81,335	121.1
Remaining Polk County	84	99	17.9	23,829	53,476	124.4

Sources: 1963 and 1972 U.S. Census of Wholesale Trade, Minnesota and North Dakota

Retail trade activity has also experienced a significant increase in the urbanized study area. Grand Forks and Grand Forks County have both had modest increases in numbers of establishments and substantial increases in sales volume, as shown in Table 46; however, Grand Forks County, excluding Grand Forks, had a decline in numbers of businesses, with a modest increase in total dollar volume. Retail trade in the Polk County and East Grand Forks areas was indicated by modest increases in sales volume for both the city and county, along with a slight decrease in business numbers for the county. Excluding East Grand Forks, the remaining area of the county experienced a slightly higher loss in numbers of businesses (4.6% vs. 2.0%), but a greater increase in sales volume, due to retail trade activity in Crookston and other county communities.

TABLE 46

RETAIL TRADE 1963-1972

Location	Number of Establishments 1963	1972	% Change 1963-1972	Wholesale Sales 1963 x $1000	1972 x $1000	% Change 1963-1972
Grand Forks	293	394	34.5	58,268	139,042	138.6
Grand Forks County	440	510	15.9	68,556	152,869	123.0
Remaining Grand Forks County	147	116	-21.1	10,288	13,827	34.4
East Grand Forks	68	75	10.3	10,228	12,214	19.4
Polk County	395	387	-2.0	42,042	56,796	35.1
Remaining Polk County	327	312	-4.6	31,814	44,582	40.1

Sources: 1963 and 1972 U.S. Census of Wholesale Trade, Minnesota and North Dakota

Of the Grand Forks and Grand Forks County retail trade activi.'es, general merchandising, food stores and auto dealerships are the most significant, accounting for about one-half of the trade. In Polk County, food stores, auto dealers and service stations dominate the trade, accounting for 52 percent of total county retail sales in 1972.

The urbanized study area is also an important government and private service center. Principal governmental activities include the University of North Dakota, the U.S. Potato Research Center, the U.S. Post Offices, the U.S. Energy Research Center, the North Dakota State Mill and the U.S. Department of Agriculture's Human Nutrition Laboratory. Private services include two private testing laboratories, professional consultants, health care services (State Medical Center in Grand Forks, clinics, etc), banking facilities and other financial institutions. Area financial growth, as indicated by bank deposits, debits and savings accounts, is shown in Table 47.

TABLE 47

GRAND FORKS-EAST GRAND FORKS FINANCIAL GROWTH

	Bank Deposits	Bank Debits	Savings and Loan Savings Accounts
1950	$ 33,729,430	$ 265,051,000	$ 4,566,315
1960	54,598,803	469,380,000	32,497,650
1970	80,159,100	700,028,000	58,615,200
1971	131,104,000	1,175,004,000	100,985,000
1972	144,710,346	1,293,876,000	132,920,004
1973	158,913,370	1,493,652,000	140,147,174
1974	167,723,533	1,710,179,000	160,034,000
1975	199,696,706	2,154,324,000	210,979,330

Source: Grand Forks Industrial Development Commission

Aside from convention activities, tourist trade in the immediate study area is not a significant activity, in terms of sales volume, and is probably hampered by the lack of variety of natural features such as open water bodies, forested areas and hills in the immediate area. The bulk of tourist related trade in the area is most closely related to convention activities, the motel-hotel trade and eating and drinking establishments. Polk County tourism during 1974 accounted for about 1.6 percent of gross retail sales, as compared to the 3.2 percent statewide county average. As would be expected in this area, lodging and food and drink sales accounted for the greatest share of county tourist revenue, with 22 and 33 percent of total expenditures, respectively.

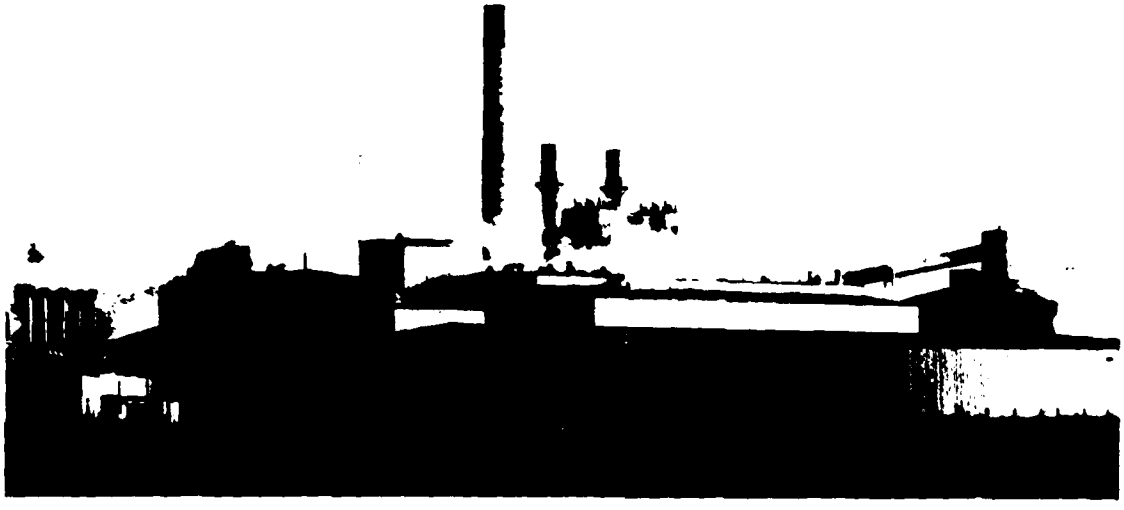
Beet sugar refining, potato processing and related activities are the leading industrial activities in the Grand Forks-East Grand Forks area. Of the 10 major city employers in East Grand Forks in 1976, sugar refining, potato processing and related activities accounted for 57.8 and 19.8 percent of the industrial employment, respectively. Other major industrial activity, based on industry employment, includes processing of dairy products, grain milling and seed processing, production of chemicals and fertilizers and soft drink bottling. Manufacturing activities, aside from chemicals and fertilizers, include concrete products, woodworking, farm equipment and other machinery, and tool and machine works. A tabulation of local industries by type and number is given inTable 48.

TABLE 48

LOCAL INDUSTRIES
GRAND FORKS-EAST GRAND FORKS

Industry Type	Number
Construction Contractors	14
Fertilizer and Chemicals	8
Potato Processing	7
Concrete Products	4
Soft Drink Bottling	2
Potato Equipment	3
Farm Machinery	2
Tool & Machine Works	3
Dairy Products	3
Printing, Signs, Displays, etc.	7
Feed and Seeds	2
Sugar Beet Refining	1
Flour Products	2
Other	11

Source: Grand Forks Industrial Development Commission



Industrial activity in the Grand Forks County study area outside of the urbanized area is generally limited to grain storage and transfer facilities and potato storage facilities in the smaller communities, gravel mining operations and concrete products. There is no significant industrial or manufacturing activity other than agriculture in the rural Polk County study area.

Future industrial expansion in the area is facilitated by an 86-acre industrial park and other smaller sites in Grand Forks, and three sites totaling nearly 200 acres in East Grand Forks. All necessary service facilities are available to these sites. Site development is coordinated by established industrial development groups in both communities.

KEY REFERENCES

Grand Forks Industrial Development Commission, **Local Industries,** Grand Forks, 1976

North Dakota State Department of Economic Development, **Community Profile, Emerado,** Bismarck, 1976

Bureau of the Census, **1972 Census of Retail Trade - Minnesota,** 1974

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Bureau of the Census, **1972 Census of Wholesale Trade - Minnesota,** 1974

Bureau of the Census, **1972 Census of Manufacturers - Minnesota,** 1974

Bureau of the Census, **1972 Census of Manufacturers - North Dakota,** 1974

Bureau of the Census, **1967 County Business Patterns, Minnesota,** 1969

Bureau of the Census, **1967 County Business Patterns, North Dakota,** 1969

City Planning Office, **Community Planning Data, City of Grand Forks,** Grand Forks, 1975

North Dakota Business and Industrial Development Department, **North Dakota Growth Indicators,** Bismarck, Revised November 1976

OCCUPATIONAL STRUCTURE

OCCUPATIONS

The Grand Forks-East Grand Forks urban area has a fairly diversified employment base and continues to grow as an important regional trade, manufacturing, service and educational center. Agricultural employment has experienced a marked decrease during the past two decades, with off-setting increases in manufacturing, education and various services.

The Grand Forks-East Grand Forks metropolitan area draws its work force from a population of around 200,000 people located within 30 to 40 miles of the urban center. Enhancing this work force are graduates from the University, a local business college and area post-high school training facilities. As indicators of area labor force growth, the Grand Forks County work force increased by 19.7 percent between 1972 and 1976, along with a 15.8 percent increase in Polk County during the period 1970-75. Of all persons 16 years of age or older and capable of working, 58.6 and 54.4 percent, respectively, are included in the Grand Forks County and Polk County labor pools. While Grand Forks includes over 65 percent of the county work force, East Grand Forks has a lesser impact on the area, with about 24 percent of the county work force, as shown on Table 49.

TABLE 49

LABOR FORCE - 1970

	Grand Forks County	Grand Forks	Grand Forks Base	Polk County	East Grand Forks
Total persons 16 years and older	42,277	27,818	6,529	23,417	5,023
Total labor force	24,798	16,152	4,660	12,732	3,041
Labor force -					
Male (%)	66.5	58.3	90.2	63.6	61.1
Female (%)	33.5	41.7	9.8	36.4	38.9
Civilian labor force	19,932	15,606	543	12,618	2,938
Employed	19,078	14,892	502	11,884	2,798
Unemployed	854	714	41	734	140
Percent Unemployed	4.3	4.6	7.5	5.8	4.8

Sources: References 157, 158

Unemployment in the area has fluctuated widely but has recently moderated, as indicated by a 4.7 percent Polk County rate in 1975. U.S. census data for 1970 show 4.6 and 4.3 percent unemployment rates, respectively, for Grand Forks and Grand Forks County. The 1970 female unemployment rate exceeded the male rate by about 4 percent in Grand Forks and by nearly 3 times in East Grand Forks. The high proportion of seasonal employment in East Grand Forks is a probable factor in the city's female unemployment rate.

The Grand Forks Air Base has a sizeable impact on the Grand Forks County labor force, as it accounted for about 19 percent of the total force in 1970. Of the 1970 Base work force, 88 percent were military. Of the nonmilitary, women accounted for 78 percent of the labor force and a similar percentage of unemployed in 1970.

The largest employment group by occupational type in 1970 in Grand Forks County was clerical and kindred workers, accounting for about 21 percent of the total employment, closely followed by service workers with 20 percent. In Polk County, service workers accounted for about 31 percent of total employment, followed by clerical and kindred workers with 25 percent. The occupational group with the lowest percentage of workers in both counties was farm laborers, followed by other laborers. Other occupational group percentages and data for the two study area counties are shown in Table 50. Study area employment (1970 census) by occupational category for each census district is shown in Table 51 and displayed graphically on Plates 21 and 22.

TABLE 50

OCCUPATION BY TYPE AND BY COUNTY - 1970

Occupation	East Grand Forks	Polk County	Grand Forks	Grand Forks County
Professional, technical and kindred workers	273	1,308	3,074	3,550
Managers and administrators, except farm	277	1,054	1,690	1,985
Sales workers	237	682	1,314	1,504
Clerical and kindred workers	375	1,411	2,488	3,029
Craftsmen, foremen and kindred workers	407	1,370	1,725	2,204
Operatives, including transport	420	1,508	1,243	1,599
Laborers, except farm	136	517	502	643
Farmers and farm managers	29	1,507	73	947
Farm laborers and farm foremen	29	438	65	283
Service workers, including private household	615	2,089	2,718	3,334
Totals: Employed, 16 years and over	2,798	11,884	14,892	19,078

Between 1950 and 1970, employment in agriculture in Polk and Grand Forks Counties declined 65 and 60 percent, respectively. Employment in the transportation industry decreased 31 and 47 percent, respectively, for the counties over the same period. In contrast, as shown in Table 52, employment in manufacturing and education increased. From 1950 to 1970, manufacturing employment in Polk and Grand Forks Counties increased 114 and 28 percent, respectively. Education employment increased 82 and 126 percent, respectively, in the two counties between 1960 and 1970. With declining birth rates and lower elementary school enrollments, it is unlikely that future educational employment will show significant growth. Employment data for East Grand Forks and Grand Forks are shown in Table 53.

TABLE 51

EAST GRAND FORKS OCCUPATIONS

Enumeration District	Professional, etc.		Farm & Labor		Other	
	#	%	#	%	#	%
16	22	16.4	8	6.0	104	77.6
17	34	8.5	44	11.0	323	80.5
18	91	23.6	10	2.6	285	73.8
19	0	0.0	0	0.0	10	100.0
20	47	12.1	33	8.5	310	79.4
21	52	29.4	26	14.7	99	55.9
22	38	17.5	16	7.4	163	75.1
24	5	33.3	0	0.0	10	66.7
25	96	29.4	8	2.4	223	68.2
26	90	34.0	10	3.8	165	62.2
27	75	15.8	39	8.2	362	76.0
15	17	13.5	50	39.7	59	46.8
29	25	15.7	32	20.1	102	64.2
28	18	14.6	6	4.1	100	81.3
14	5	10.2	5	10.2	39	79.6

TABLE 51 CON'T

GRAND FORKS OCCUPATIONS

Enumeration District	Professional, etc.		Farm & Labor		Other	
	#	%	#	%	#	%
32	193	40.9	0	0.0	279	59.1
34	5	2.5	36	17.8	161	79.7
35	29	7.3	25	6.3	342	86.4
36	33	9.9	27	8.1	274	82.0
37	72	26.8	20	7.4	177	65.8
38A	176	39.9	26	5.9	240	54.2
38B	87	26.4	15	4.5	228	69.1
40	37	43.5	0	0.0	48	56.5
41A	319	57.4	5	0.9	232	41.7
41B	466	39.2	59	5.0	663	55.8
42	110	35.0	0	0.0	204	65.0
43	284	41.6	31	4.5	368	53.9
44	64	31.4	12	5.9	128	62.7
45	17	5.3	17	5.3	284	89.4
46	77	26.2	17	5.8	200	68.0
47	100	28.3	8	2.3	245	69.4
48	50	15.4	54	16.6	220	68.0
49	47	13.9	10	3.0	280	83.1
50	55	15.8	10	2.8	284	81.4
51	35	17.6	6	3.0	158	79.4
52	212	35.5	22	3.7	363	60.8
53	93	25.3	31	8.5	243	66.2
54	74	49.3	10	6.7	66	44.0
55	67	81.7	0	0.0	15	18.3
56	62	17.9	24	6.9	260	75.2
57	50	14.0	21	5.8	287	80.2
58	72	15.3	23	4.9	376	79.8

TABLE 51 CON'T

GRAND FORKS OCCUPATIONS

Enumeration District	Professional, etc.		Farm & Labor		Other	
	#	%	#	%	#	%
59	47	11.9	30	7.6	318	80.5
60	39	32.3	5	4.1	77	63.6
61	105	25.5	4	1.0	302	73.5
62A	25	19.4	4	3.1	100	77.5
62B	20	14.1	0	0.0	122	85.9
63A	97	27.5	15	4.2	241	68.3
63B	145	26.6	11	2.0	389	71.4
64	203	43.2	19	4.0	248	52.8
65	242	44.5	27	5.0	274	50.5
66A	78	37.7	0	0.0	129	62.3
66B	147	67.7	0	0.0	70	32.3
66C	196	58.0	5	1.5	137	40.5
67	313	49.9	11	1.8	303	48.3
69	5	22.7	12	54.5	5	22.7
70A	38	24.7	17	11.0	99	64.3
70B	67	34.4	0	0.0	128	65.6
11A	93	18.5	14	2.8	395	78.7
13	10	11.1	0	0.0	80	88.9
14	42	17.9	87	37.2	105	44.9
01	20	22.8	9	10.2	59	67.0
03	16	10.4	66	42.8	72	46.8
04	5	3.7	68	50.4	62	45.9
05	3	1.8	63	38.7	97	59.5
27	14	12.3	23	20.4	76	67.3
29	29	15.6	81	43.5	76	40.9
30	9	6.7	100	73.5	27	19.8

TABLE 52

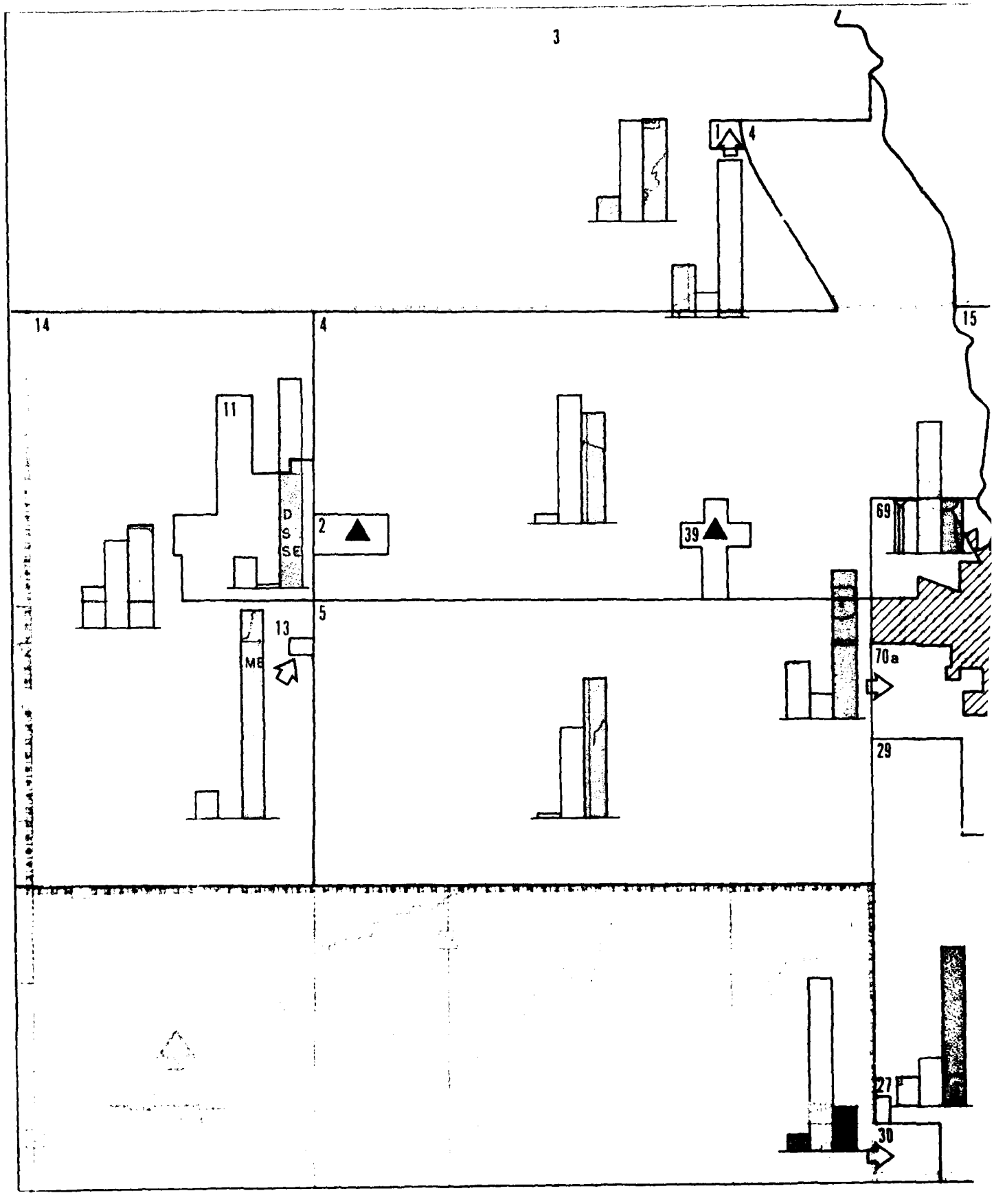
EMPLOYMENT BY INDUSTRY

Industry	POLK COUNTY			GRAND FORKS COUNTY		
	1950	1960	1970	1950	1960	1970
Agriculture	5,748	3,915	2,004	3,255	2,116	1,281
Construction	638	727	612	870	1,206	960
Manufacturing	608	695	1,301	1,053	968	1,331
Transportation	835	630	575	1,401	1,003	965
Commun. & Utilities	285	281	451	455	563	638
Wholesale Trade	469	580	495	884	845	839
Retail Trade	1,824	2,177	2,203	2,635	3,408	3,846
Finance, Insurance	191	244	282	428	579	707
Service						
Business & Repair	374	198	249	347	307	374
Education	459	638	1,161	---	---	3,587
Other Service	939	1,371	1,793	2,690	4,385	2,965
Public Admin.	323	358	443	547	2,665	1,116
Other	202	612	315	324	447	469
Totals	12,895	12,426	11,884	14,889	18,492	19,078

TABLE 53

EMPLOYMENT BY INDUSTRY

Industry	East Grand Forks	Grand Forks
Construction	158	748
Manufacturing	310	1,135
Transportation	230	763
Commun. & Utilities	81	587
Wholesale & Retail Trade	905	3,864
Finance, Insurance, Business and Repair Services	158	889
Professional and Related Services	302	369
Educational	283	3,116
Public Administration	155	724
Hospitals, Health Services	---	1,173
Other	216	1,524
Total Employed, 16 years and over	2,798	14,892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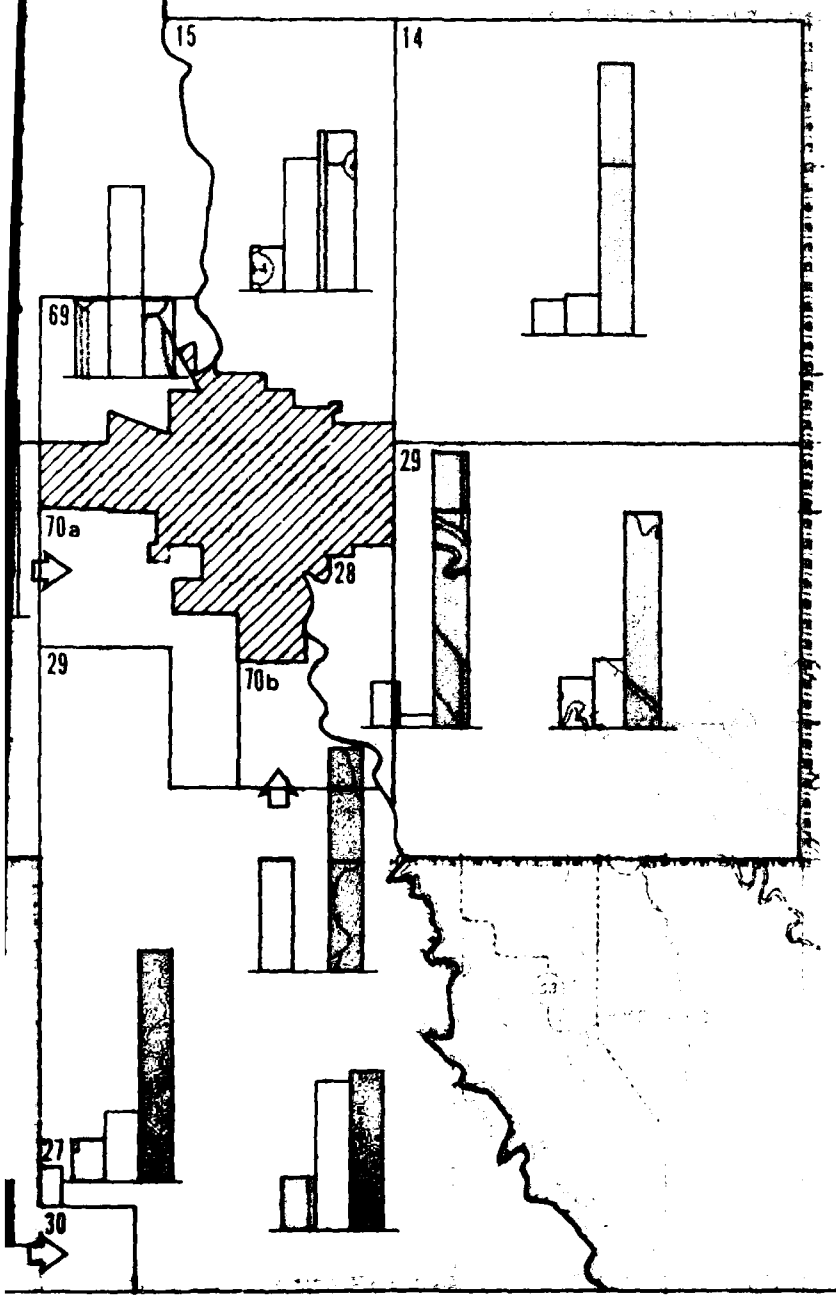
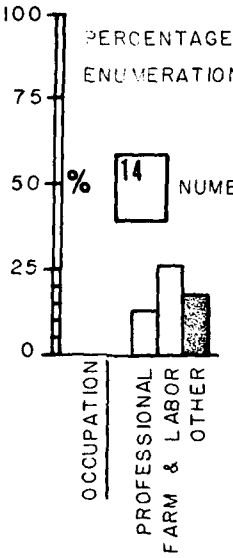


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

OCCUPATION GROUPING
FOR RURAL AREAS



PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT

14 NUMBER AND DISTRICT BOUNDARY

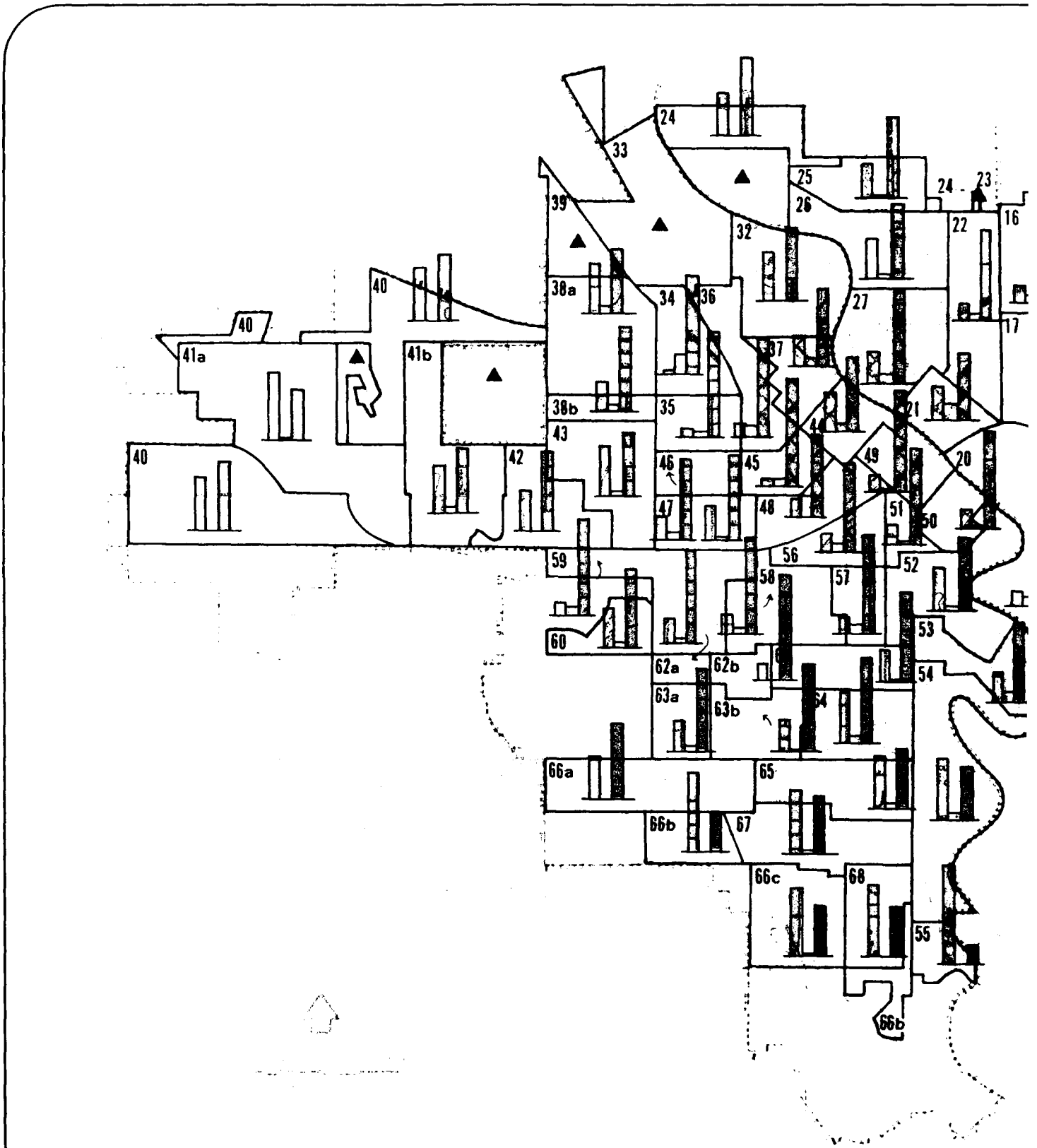
PRECISE PERCENTAGES GIVEN IN TABLE 51

▲ DATA NOT AVAILABLE

OCCUPATION GROUPINGS FOR THE GRAND FORKS – EAST GRAND FORKS URBAN AREA PRESENTED ON PLATE 22

SOURCE: REFERENCE 156.

PLATE 21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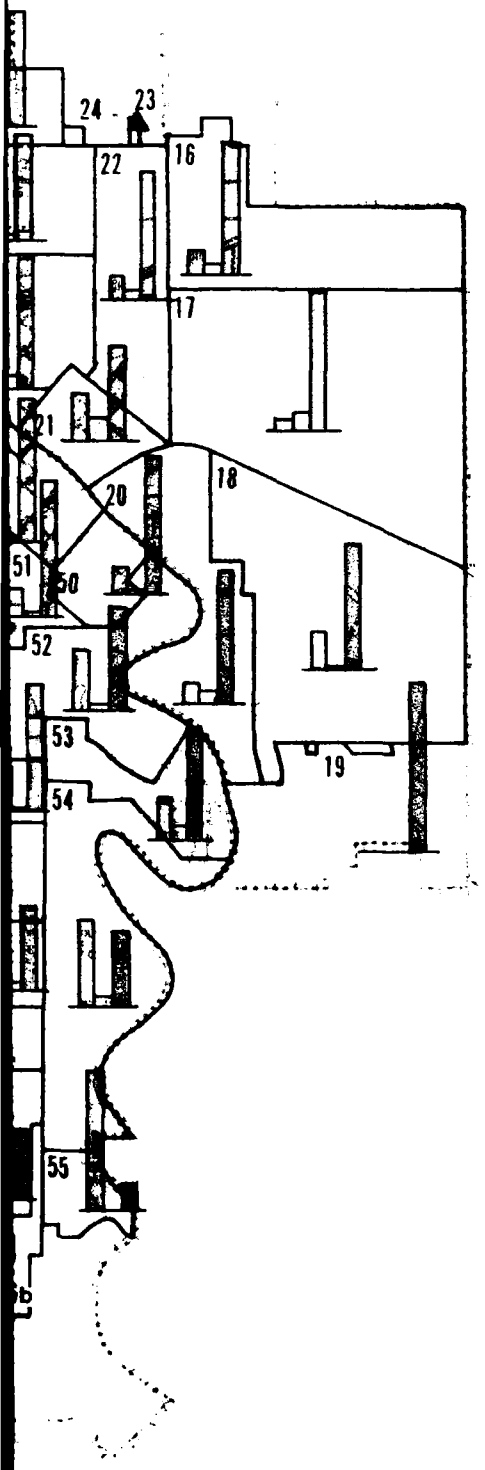
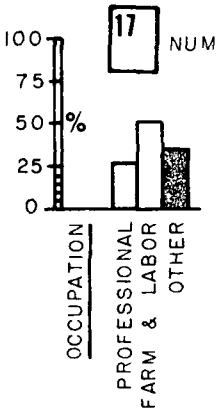


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

OCCUPATION GROUPING FOR THE GRAND FORKS – EAST GRAND FORKS URBAN AREA

PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT



NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES GIVEN IN TABLE 51

▲ DATA NOT AVAILABLE

OCCUPATION GROUPINGS FOR THE RURAL AREAS OUTSIDE GRAND FORKS – EAST GRAND FORKS PRESENTED ON PLATE 21

SOURCE: REFERENCE 156.

PLATE 22

INCOME

The 1974 median family income of the 7-county Minnesota region including Polk County was $9,565, compared to the statwide average of $9,931. Median family income in Polk County for 1969 was $7,858, as compared to the regional average of $7,108, the statewide average of $9,931, and East Grand Forks average family income of $9,156. Similar data for Grand Forks and Grand Forks County show 1969 median family incomes of $9,109 and $8,458, respectively, as compared to the State average of $7,838.

Per capita income is fairly consistent throughout the study area, ranging from $2,318 in Polk County to a 1970 high of $2,709 in the city of Grand Forks. Per capita income has also experienced a general increase throughout the area, as evidenced by a 7.2 percent increase, for BEA Economic Area 092 between 1962 and 1970.

Disparities in family income by area become evident when various income brackets are compared. Table 54 shows that, in 1969, more families in Polk County (35.6%) had an income of less than $5,000 than in all other areas. Grand Forks has the fewest lower income families (18.5%) and the greatest percentage of families earning over $15,000 (17.0%). The geographical distribution (by census enumeration district) of study area family income is shown in Table 55 and graphically on Plates 23 and 24.

TABLE 54

INCOME DISTRIBUTION BY CITY AND COUNTY

	Grand Forks County	Grand Forks	Polk County	East Grand Forks
Per Capita Income	$ 3,480	$ 2,709	$ 2,318	$ 2,641
Median Family Income	8,458	9,109	7,858	9,156
Income (%)				
$0-5,000	---	18.5	35.6	20.8
$5-10,000	---	37.4	37.6	37.5
$10-15,000	---	27.1	18.4	30.4
$15,000 and over	14.7	17.0	8.4	11.3

Source: U.S. Census - 1970

TABLE 55

INCOME DISTRIBUTION

Grand Forks Area

Enumeration District	Family Income: Under $5,000 #	Under $5,000 %	$5-14,999 #	$5-14,999 %	$15,000 and Over #	$15,000 and Over %
32	14	4.6	232	76.6	57	18.8
34	10	8.1	97	78.9	16	13.0
35	31	12.4	209	83.6	10	4.0
36	67	25.9	177	68.3	15	5.8
37	64	33.9	112	59.2	13	6.9
38A	29	13.7	147	69.3	36	17.0
38B	41	23.0	89	50.0	48	27.0
40	0	0.0	19	55.9	15	44.1
41A	181	42.3	237	55.4	10	2.3
41B	20	11.4	116	65.9	40	22.7
42	14	25.4	26	47.3	15	27.3
43	38	10.2	293	79.0	40	10.8
44	43	32.1	76	56.7	15	11.2
45	93	39.7	127	54.3	14	6.0
46	23	13.1	131	74.9	21	12.0
47	43	21.4	143	71.1	15	7.5
48	51	29.7	101	58.7	20	11.6
49	32	36.4	56	63.6	0	0.0
50	45	23.7	125	65.8	20	10.5
51	44	38.9	55	48.7	14	12.4
52	74	17.5	295	69.6	55	12.9
54	4	4.1	23	23.7	70	72.2
55	0	0.0	11	17.5	52	82.5
56	84	30.0	192	68.6	4	1.4
57	39	18.9	147	71.4	20	9.7
58	77	25.0	221	71.8	10	3.2
59	37	15.0	194	78.5	16	6.5
60	0	0.0	60	78.9	16	21.1
61	55	19.7	195	69.6	30	10.7
62A	0	0.0	60	85.7	10	14.3
62B	32	32.0	49	49.0	10	19.0
63A	17	7.4	180	77.9	34	14.7
63B	33	10.2	242	74.4	50	15.4
64	61	17.5	207	59.3	81	23.2
65	69	19.9	175	50.6	102	29.5
66A	5	3.8	85	64.4	42	31.8

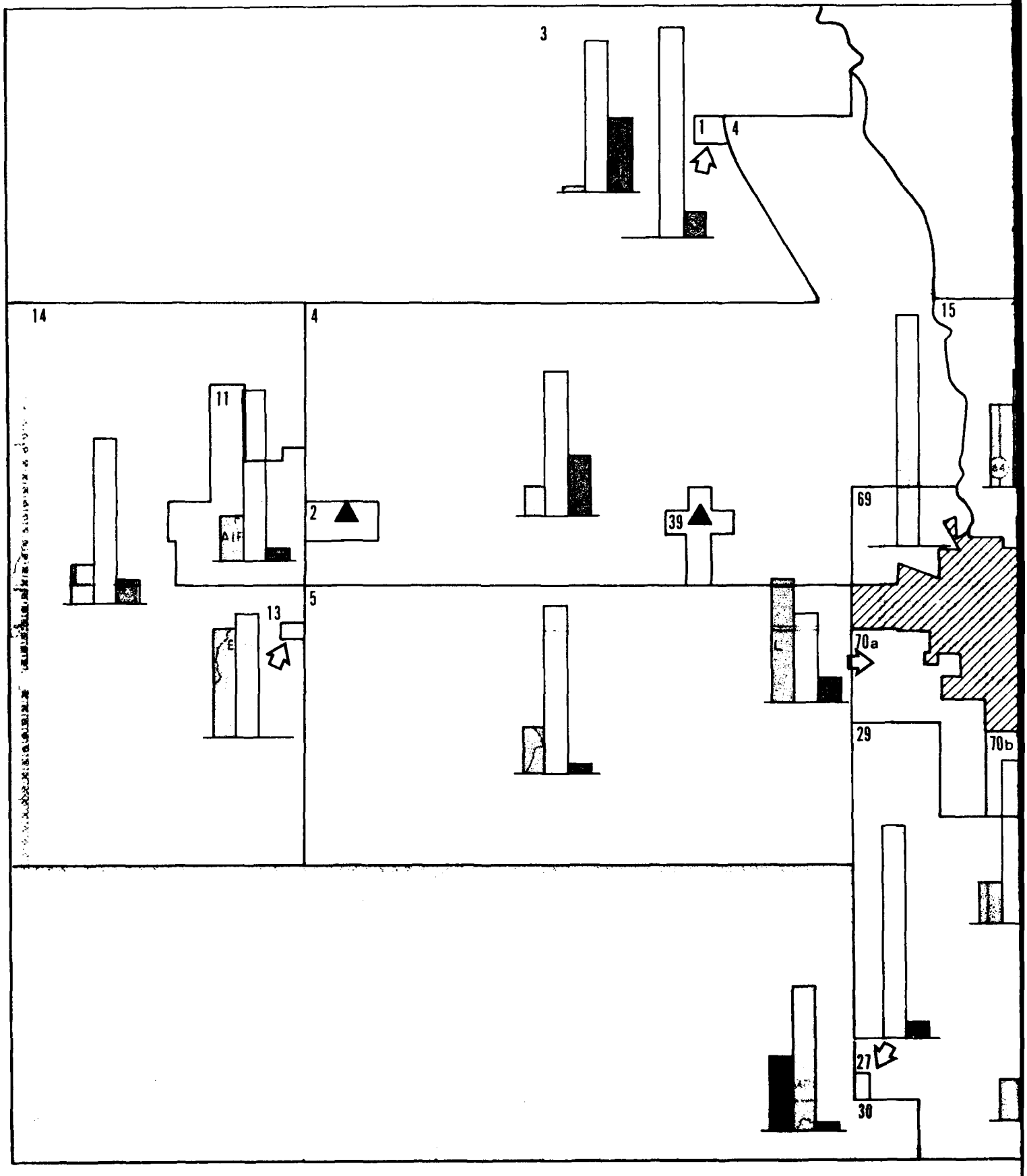
TABLE 55 CON'T

INCOME DISTRIBUTION

East Grand Forks Area

Enumeration District	Family Income: Under $5,000		$5-14,999		$15,000 and Over	
	#*	%	#*	%	#*	%
66B	28	18.5	94	62.3	29	19.2
66C	21	10.6	97	49.0	80	40.4
67	39	10.4	212	56.2	126	33.4
68	10	3.6	111	39.6	159	56.8
69	0	0.0	22	100.0	0	0.0
70A	62	50.4	48	39.0	13	10.6
70B	27	18.8	102	70.8	15	10.4
11	379	20.0	1,593	74.3	60	5.7
13	69	46.9	78	53.1	0	0.0
14	37	17.5	151	71.6	23	10.9
01	0	0.0	62	89.9	7	10.1
03	4	3.2	81	64.8	40	32.0
05	22	21.4	76	73.8	5	4.8
29	18	18.0	66	66.0	16	16.0
27	0	0.0	63	92.6	5	7.4
30	45	33.3	86	63.8	4	2.9
16	21	20.6	81	79.4	0	0.0
17	127	32.5	245	62.7	19	4.8
18	64	21.2	214	70.9	24	7.9
19	0	0.0	0	0.0	5	100.0
20	86	32.0	173	64.3	10	3.7
21	160	63.5	73	29.0	19	7.5
22	129	51.2	117	46.4	6	2.4
24	0	0.0	5	50.0	5	50.0
25	33	15.1	149	68.0	37	16.9
26	23	11.9	97	50.3	73	37.8
27	141	35.4	230	57.8	27	6.8
15 (Grand Forks Twn)	33	36.7	47	52.2	10	11.1
29 (Huntsville Twn)	25	21.9	80	70.2	9	7.9
28 (Rinehart Twn)	16	18.8	56	65.9	13	15.3
14 (Sullivan Twn)	20	39.2	15	29.4	16	31.4

* Includes both families and unrelated individuals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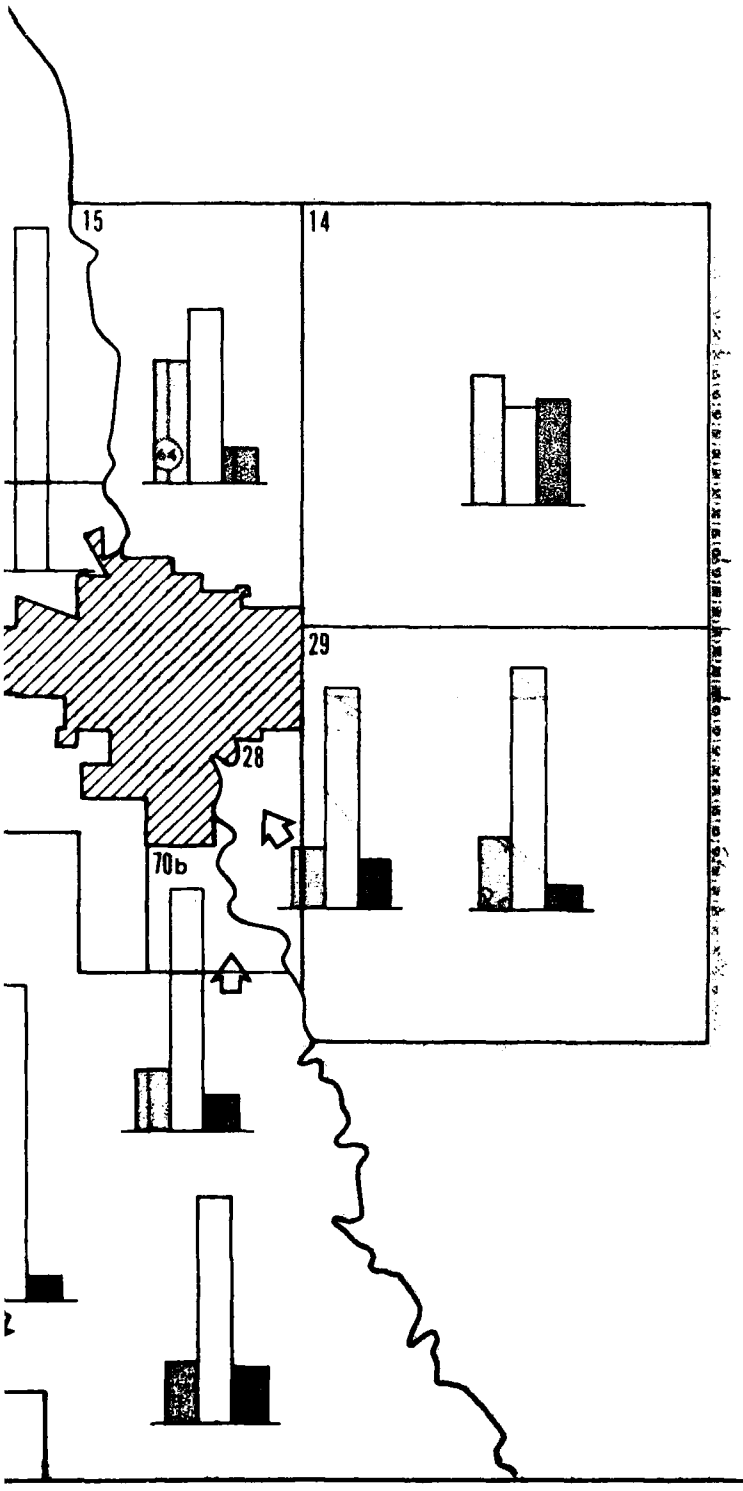
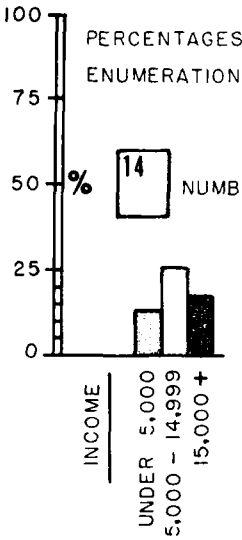


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

FAMILY INCOME FOR RURAL AREAS



PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT

14 NUMBER AND DISTRICT BOUNDARY

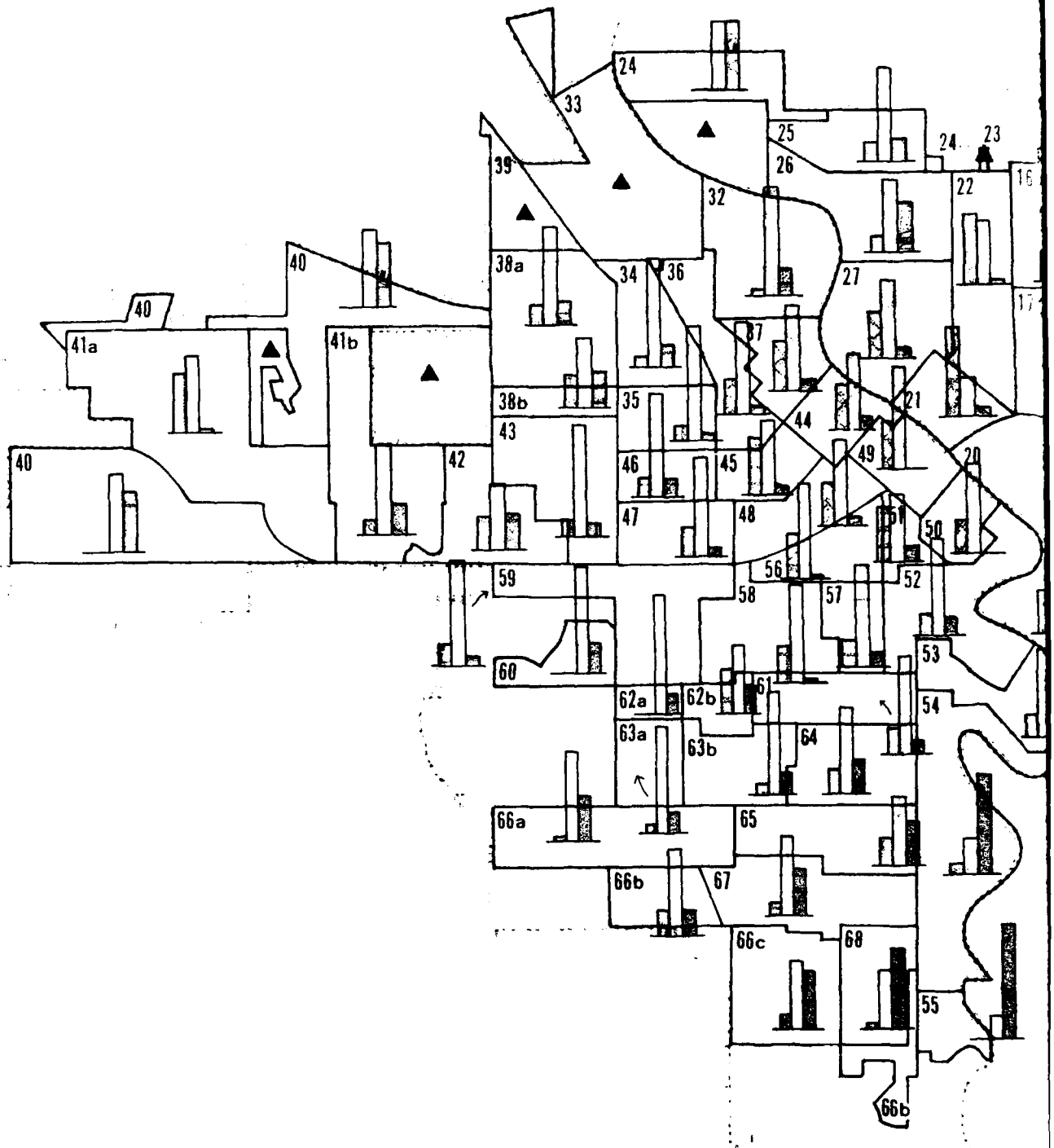
PRECISE PERCENTAGES GIVEN IN TABLE 55

▲ DATA NOT AVAILABLE

FAMILY INCOME FOR THE GRAND FORKS - EAST GRAND FORKS URBAN AREA PRESENTED ON PLATE 24

SOURCE: REFERENCE 156.

PLATE 23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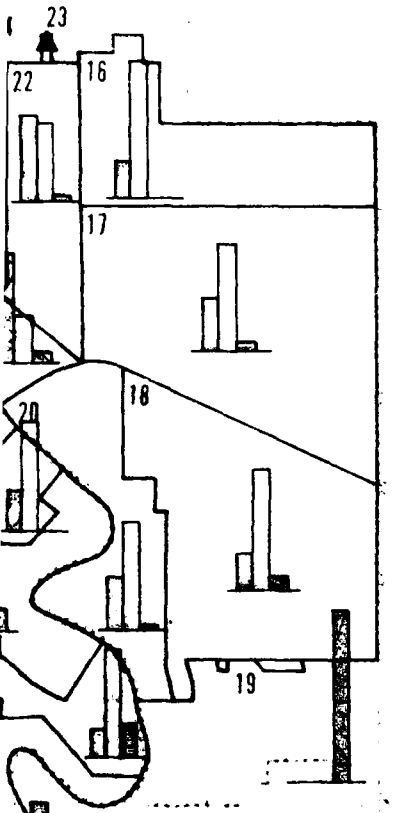
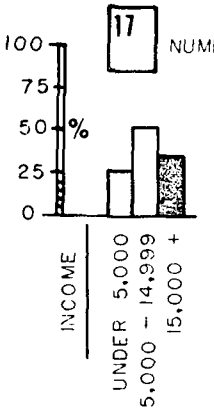


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

FAMILY INCOME FOR THE GRAND FORKS – EAST GRAND FORKS URBAN AREA

PERCENTAGES GIVEN FOR EACH ENUMERATION DISTRICT



17 NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES GIVEN IN TABLE 55

▲ DATA NOT AVAILABLE

FAMILY INCOME FOR THE RURAL AREAS OUTSIDE GRAND FORKS – EAST GRAND FORKS PRESENTED ON PLATE 23

SOURCE: REFERENCE 156.

PLATE 24

EDUCATION

The Grand Forks-East Grand Forks area is fortunate in having a high quality, complete education system for its students. Grand Forks and the immediate adjacent area is served by 14 public elementary, three junior high and two high schools. Public elementary and secondary education in the Grand Forks County study area outside the city is provided by five school districts, as shown on Plate 19 in the report section on Taxes. East Grand Forks and the adjacent Minnesota study area are organized as Independent School District No. 595, and are served by three public elementary, one junior high and one high school. Three parochial elementary schools are located in Grand Forks. One parochial elementary and one parochial high shool are located in East Grand Forks. A Bible Baptist Church school, with an average enrollment of 60 to 80 students, provides education from kindergarten through college. A vocational center and recently completed vocational-technical institute in East Grand Forks provide post-high school education in over 30 educational areas to area residents. College-level education is provided by the University of North Dakota at Grand Forks and a small business college. Enrollment at the University has increased from slightly over 3,000 in 1955 to over 8,000 in 1976. Established in 1883, the University of North Dakota has a faculty of about 700 and offers study in 12 disciplines. The University's Institute for Ecological Studies provides an important center for ecological research in the region. The North Dakota State School for the Blind at Grand Forks provides education for the visually handicapped.

Educational attainment in the region is quite high, with higher levels in the urbanized areas. Median school years completed for Grand Forks and Polk Counties are 12.4 and 9.2 years, respectively. Similar data for the Grand Forks and East Grand Forks communities are 12.5 and 12.1 years, as shown in Table 56. As a comparison, median school years completed for North Dakota and Minnesota are 12.0 and 12.2 years, respectively. Study area educational levels are presented in Table 57 and shown graphically on Plates 25 and 26 for each census enumeration district.

The impact of the University at Grand Forks is clearly shown in Table 56. The advantage to North Dakota residents is evident, in that over twice as many students in Grand Forks County completed college than in Polk County. While the percentages of

persons completing high school are comparable in the two counties, Polk County has a larger rural population which terminated its education after elementary school. Present educational requirements and the expected growth of the vocational-technical school should result in an increasing percentage of Polk County residents completing high school and post-high school studies.

TABLE 56

EDUCATIONAL CHARACTERISTICS

Location	Total Population 25 years and over	Years of School Completed as a Percent of 25 years and over Population: Elementary 8 years	High School 4 years	College 1-3 years	College 4 years	Median School Years Completed
Grand Forks	8,148	18.3	25.8	15.5	22.8	12.5
Grand Forks County	13,544	19.4	29.5	13.3	19.5	12.4
East Grand Forks	3,710	21.8	32.9	11.7	8.8	12.1
Polk County	9,257	32.7	25.1	6.8	7.0	9.2

Source: U.S. Census, Minnesota and North Dakota, General Social and Economic Characteristics, 1970

TABLE 57

EDUCATION

Grand Forks Area

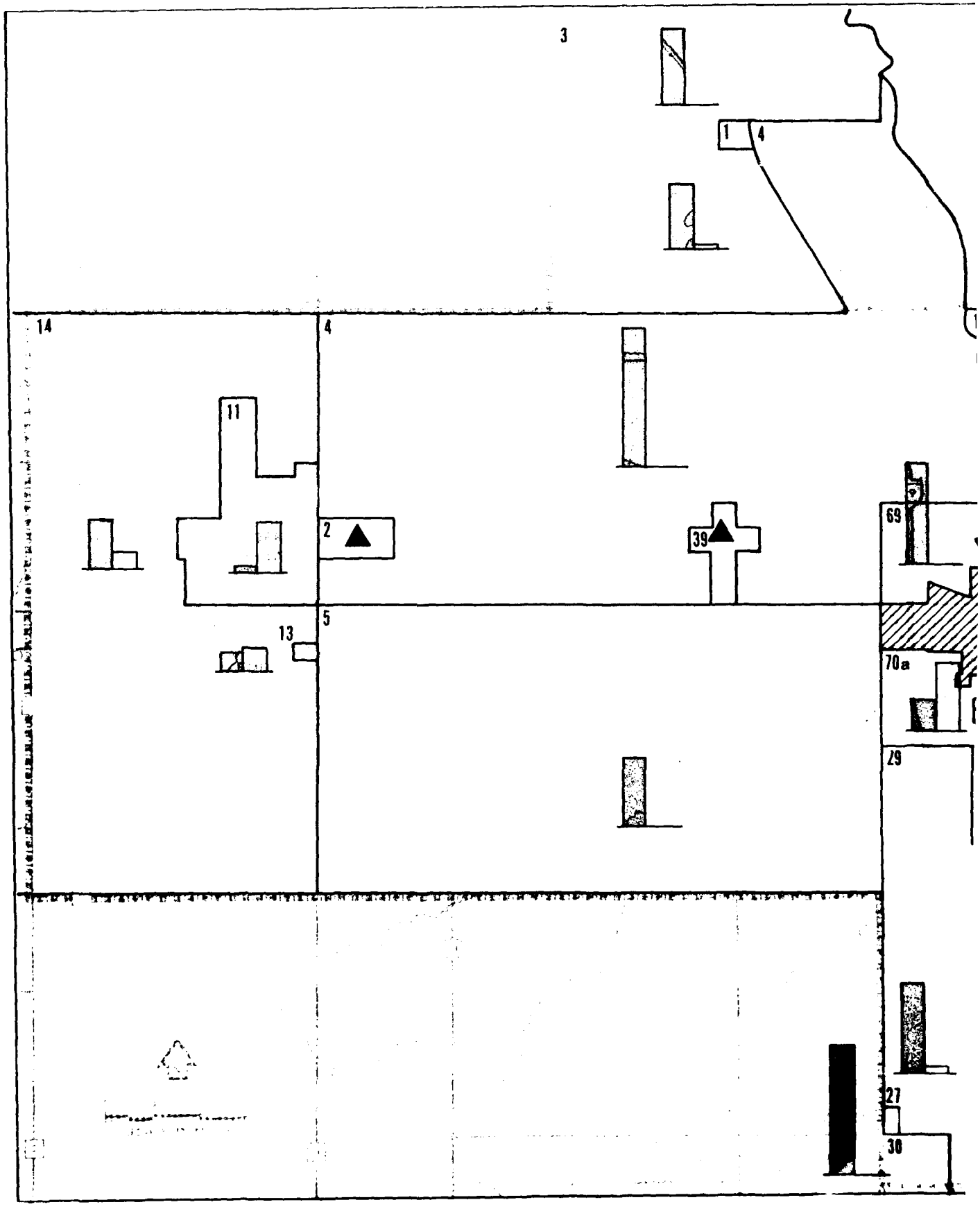
Enumeration District	Grade School Only		4 Years College Complete	
	#	%*	#	%*
50	107	28.0	61	16.0
51	97	32.1	21	7.0
52	155	19.0	155	19.0
53	123	18.1	91	13.4
54	5	2.4	61	28.9
55	0	0.0	63	52.5
56	203	38.4	43	8.1
57	165	35.9	34	7.4
58	175	36.9	27	5.7
59	108	23.1	0	0.0
60	19	12.8	15	10.1
61	102	20.0	37	7.2
62A	19	15.3	0	0.0
62B	22	17.9	0	0.0
63A	36	9.2	63	16.0
63B	72	13.2	54	9.9
64	100	14.2	182	25.8
65	71	10.4	176	25.9
66A	15	5.7	71	27.1
66B	74	22.1	87	26.0
66C	5	1.4	163	44.3
67	45	6.1	160	21.6
68	16	2.9	226	40.6
69	11	42.3	0	0.0
70A	19	14.0	39	28.7
70B	19	7.9	31	12.9
11	111	2.9	787	21.1
13	13	8.4	15	9.7
14	100	21.6	35	7.5
15	105	32.3	13	4.0
21	58	33.1	0	0.0
03	73	27.8	7	2.7
04	118	59.3	0	0.0
05	59	29.6	0	0.0
27	56	38.3	5	3.4
29	112	32.5	13	3.8
30	114	55.2	0	0.0

TABLE 57 CONT

EDUCATION

East Grand Forks

Enumeration District	Grade School Only		4 Years College Complete	
	#	%*	#	%*
16	13	11.6	5	4.5
17	157	27.6	29	5.1
18	125	24.1	39	7.5
19	5	33.3	0	0.0
20	107	23.2	19	4.1
21	95	31.8	24	8.0
22	81	26.5	5	1.6
24	31	27.2	5	4.4
25	53	16.2	59	18.0
26	37	10.1	105	28.6
27	107	17.2	35	5.6
15 (Grand Forks Twn)	32	21.8	0	0.0
29 (Huntsville Twn)	71	34.1	8	3.8
28 (Rinehart Twn)	36	20.8	14	8.1
14 (Sullivan Twn)	33	30.8	6	5.6
32	118	20.8	140	25.2
34	51	25.5	6	3.0
35	142	32.1	17	3.8
36	141	29.4	20	4.2
37	151	31.5	28	5.8
38A	57	12.8	99	22.2
38B	26	9.0	63	21.8
40	6	8.0	35	46.7
41A	0	0.0	230	59.7
41B	10	2.2	186	40.6
42	17	11.4	63	42.3
43	103	12.2	198	23.4
44	34	10.9	19	6.1
45	127	27.3	10	2.2
46	61	18.4	33	10.0
47	71	19.2	45	12.2
48	107	26.9	17	4.3
49	94	27.2	26	7.5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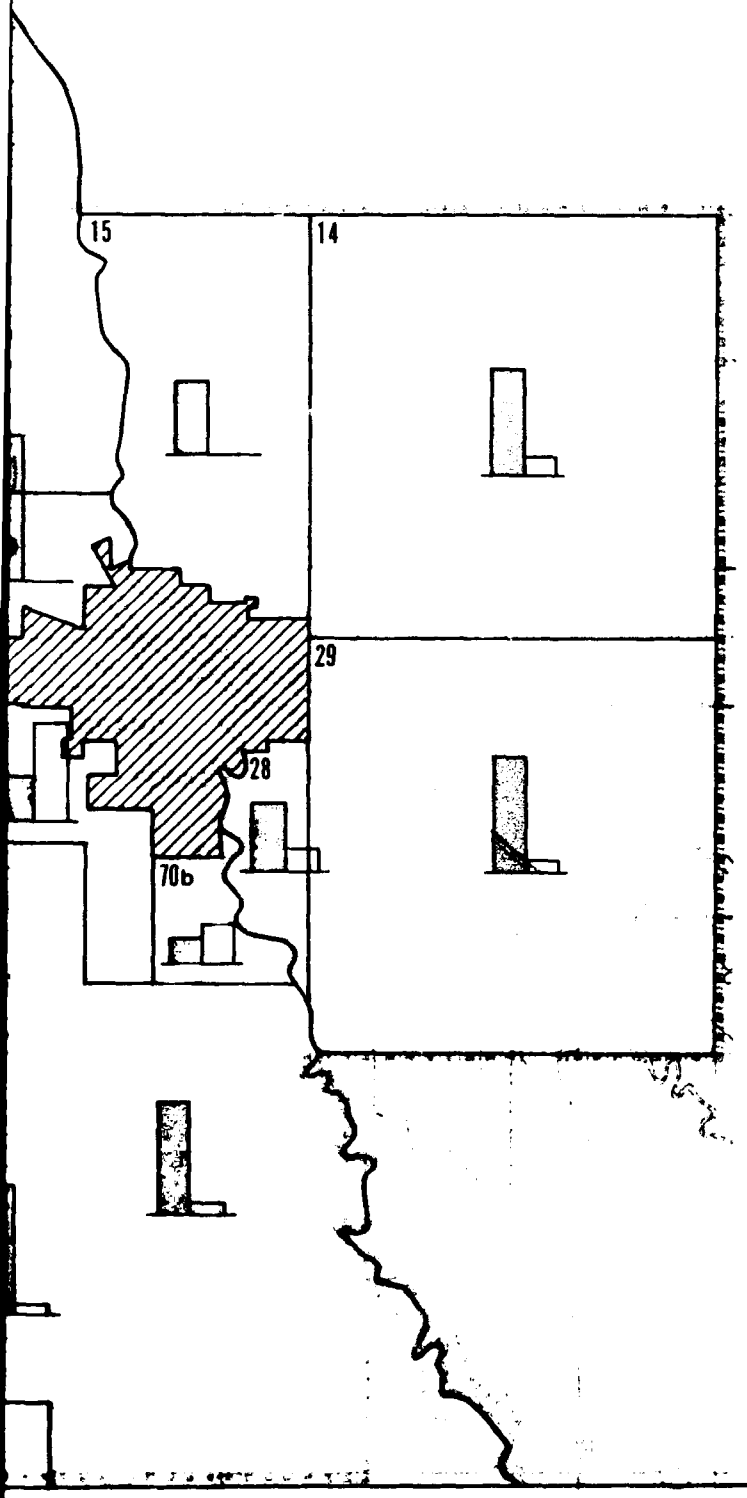
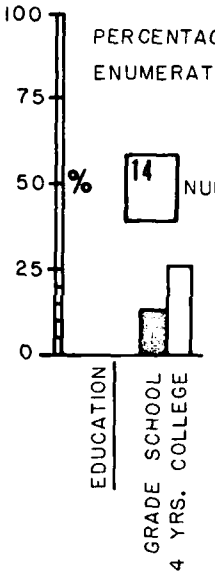


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

EDUCATION AS A PERCENTAGE
OF TOTAL POPULATION
25 YEARS AND OVER



PERCENTAGES GIVEN FOR EACH
ENUMERATION DISTRICT

14 NUMBER AND DISTRICT BOUNDARY

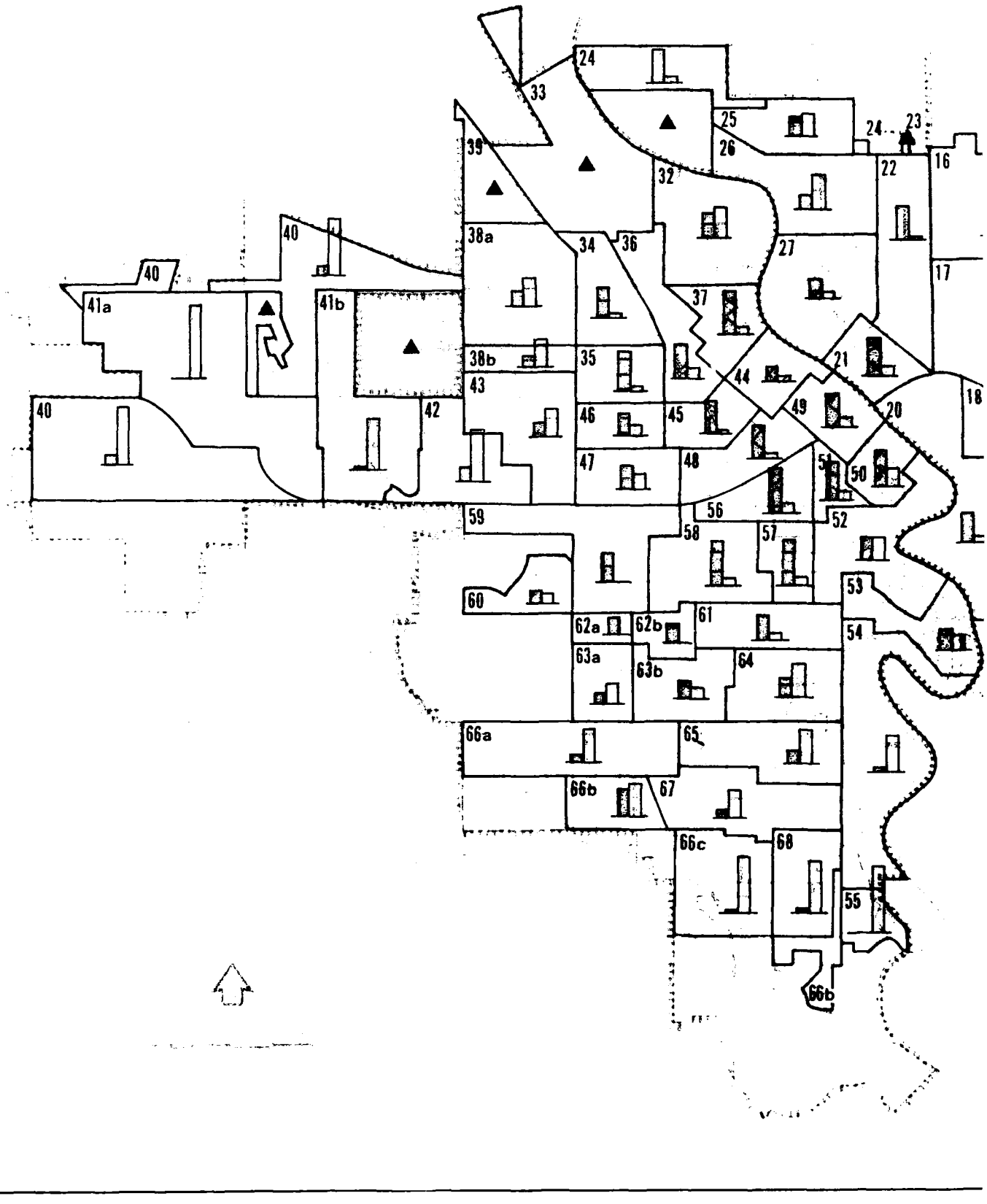
PRECISE PERCENTAGES
GIVEN IN TABLE 57

▲ DATA NOT AVAILABLE

EDUCATION OF THOSE 25 YEARS
AND OVER IN THE GRAND FORKS–
EAST GRAND FORKS URBAN AREA
PRESENTED ON PLATE 26

SOURCE: REFERENCE 156.

PLATE 25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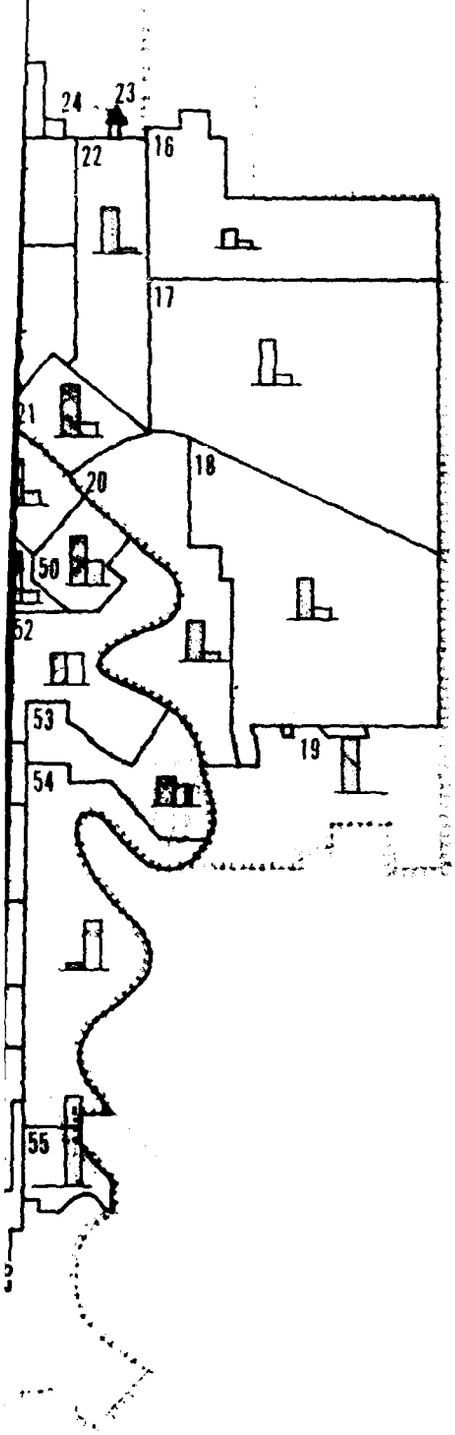
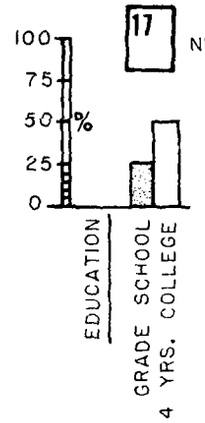


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

EDUCATION AS A PERCENTAGE OF
TOTAL POPULATION 25 YEARS AND OVER

PERCENTAGES GIVEN FOR EACH
ENUMERATION DISTRICT



NUMBER AND DISTRICT BOUNDARY

PRECISE PERCENTAGES
GIVEN IN TABLE 57

▲ DATA NOT AVAILABLE

EDUCATION OF THOSE 25 YEARS AND OVER
IN RURAL AREAS OUTSIDE GRAND FORKS -
EAST GRAND FORKS PRESENTED ON PLATE 25

SOURCE: REFERENCE 156.

PLATE 26

COMMUNITY FACILITIES

A wide variety of public and private social service facilities is available within the Grand Forks-East Grand Forks area, mostly within the specific metropolitan area of Grand Forks-East Grand Forks. These facilities include schools, hospitals, churches, museums, cultural and convention facilities, police and fire protection facilities and cemeteries. The most significant community facility in the area is probably the University of North Dakota. Established in 1883 by the Legislative Assembly of Dakota Territory, this institution provides the area with a constant source of entertainment and cultural enjoyment, ranging from various sporting events to musicals, stage plays and concerts performed at the University's Chester Fritz Auditorium. Research facilities at the University include the publicly endowed Lignite Research Center and Deep Sea Laboratory, and the Department of Agriculture's Human Nutrition Laboratory.

Also located at the University is the Chester Fritz Library, the largest in the State in terms of size and number of volumes. Other area libraries include the municipal public libraries and individual school libraries and learning centers.

Medical facilities in the metropolitan area serve a wide area and include the United Hospital complex, the UND Rehabilitation Hospital and the Grand Forks Clinic. The Rehabilitation Hospital provides a comprehensive program of rehabilitation for the people of North Dakota and surrounding area, and a clinical education setting for students from the University and other professional schools.

The public school system is divided into 7 school districts and includes 19 public schools in Grand Forks and five public schools in East Grand Forks. Augmenting these facilities are three parochial schools in Grand Forks, three parochial schools in East Grand Forks, the University, a private business college, a vocational-technical institute and the North Dakota State School for the Blind.

Plates 27 and 28 show the locations of community facilities in the rural and urban study areas respectively. Community facilities located within the study area are tabulated in Tables 58 and 59. Schools, churches, cemeteries, and other facilities are number keyed to corresponding table numbers.

TABLE 58

COMMUNITY FACILITIES - RURAL AREA

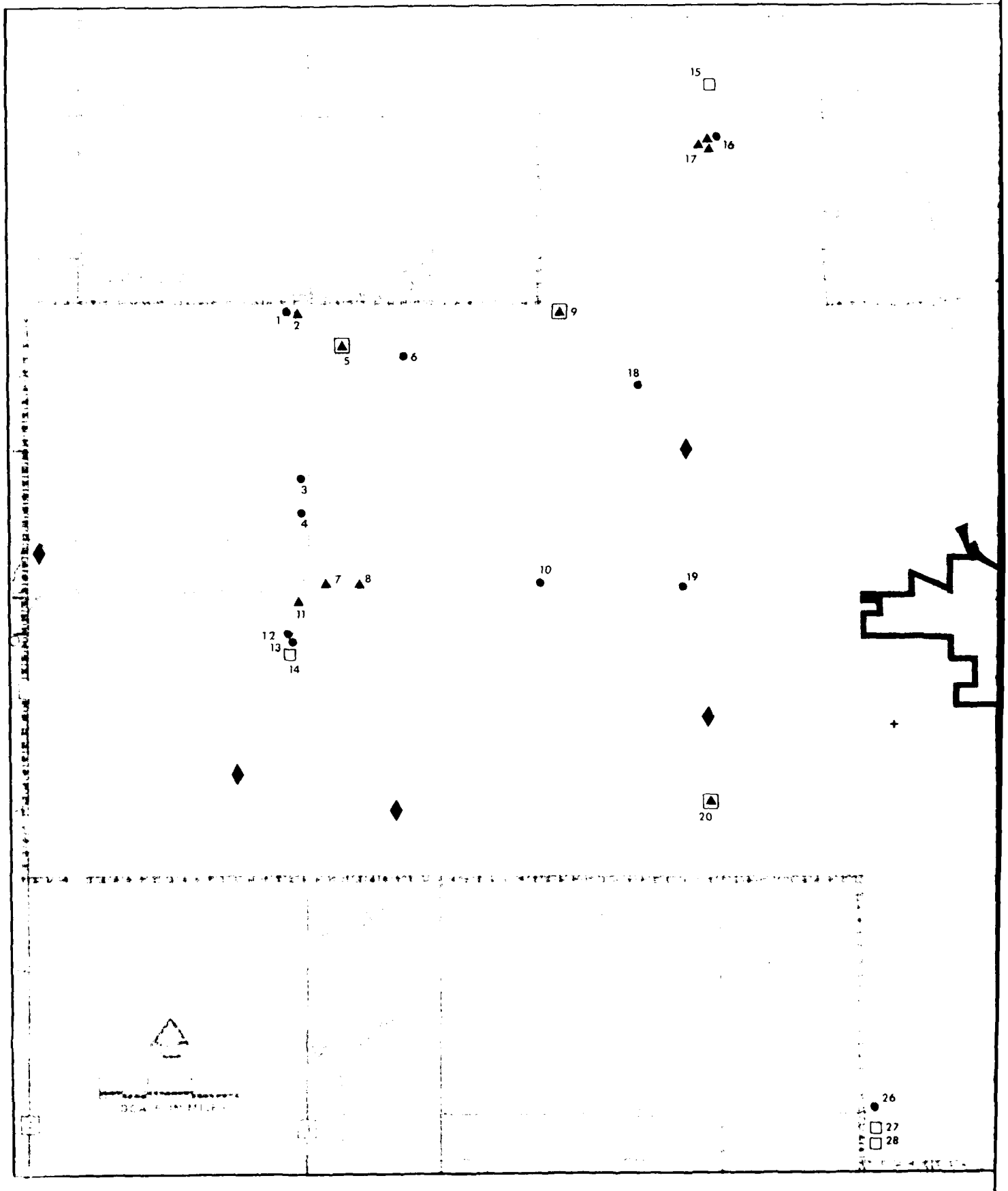
Plate Number*	Name of Facility
1	School (unknown name)
2	Church (unknown name)
3	Twining School
4	Eielson School
5	Ness Church and Cemetery
6	Mekinock School
7	Calvary Church
8	Baseview Church
9	Middle Grove Church and Cemetery
10	Oakville School
11	Ascension Church
12	Emerado Community Schools
13	Emerado Community Schools
14	Emerado Cemetery
15	St. Timothy Cemetery
16	Manvel City School
17	Manvel Community Churches (3)
18	School No. 25
19	School No. 30
20	Evanger Church and Cemetery
21	South Bethany Cemetery
22	Pleasant View School
23	Driscoll School
24	Resthaven Memorial Gardens
25	Nesbit Cemetery
26	Thompson Community School
27	Thompson Cemetery
28	St. James Cemetery
29	Walle Church and Cemetery

* See Plate 27 for Facility Locations

TABLE 59

COMMUNITY FACILITIES - URBAN AREA

Plate Number	Name of Facility
1	Calvary Cemetery
2	Memorial Park Cemetery
3	Sunset Memorial Gardens
4	Westley College
5	University of North Dakota
6	Lake Agassiz School
7	School for the Blind
8	West School
9	Valley Junior High School
10	Winshin School
11	St. James High School
12	Benjamin Franklin School
13	Lewis and Clark School
14	Holy Family School
15	Immanual School
16	Viking School
17	Schroeder Junior High School
18	South Junior High School
19	Lincoln School
20	Roosevelt School
21	Belmont School
22	St. Mary's School
23	Central High School
24	St. Michael School
25	Washington School
26	Wilder School
27	River Heights School
28	River Heights High School
29	Central High School
30	Valley School
31	Sacred Heart School
32	Crestwood School
33	Grand Forks Public Library
34	Rehabilitation Hospital
35	United Hospitals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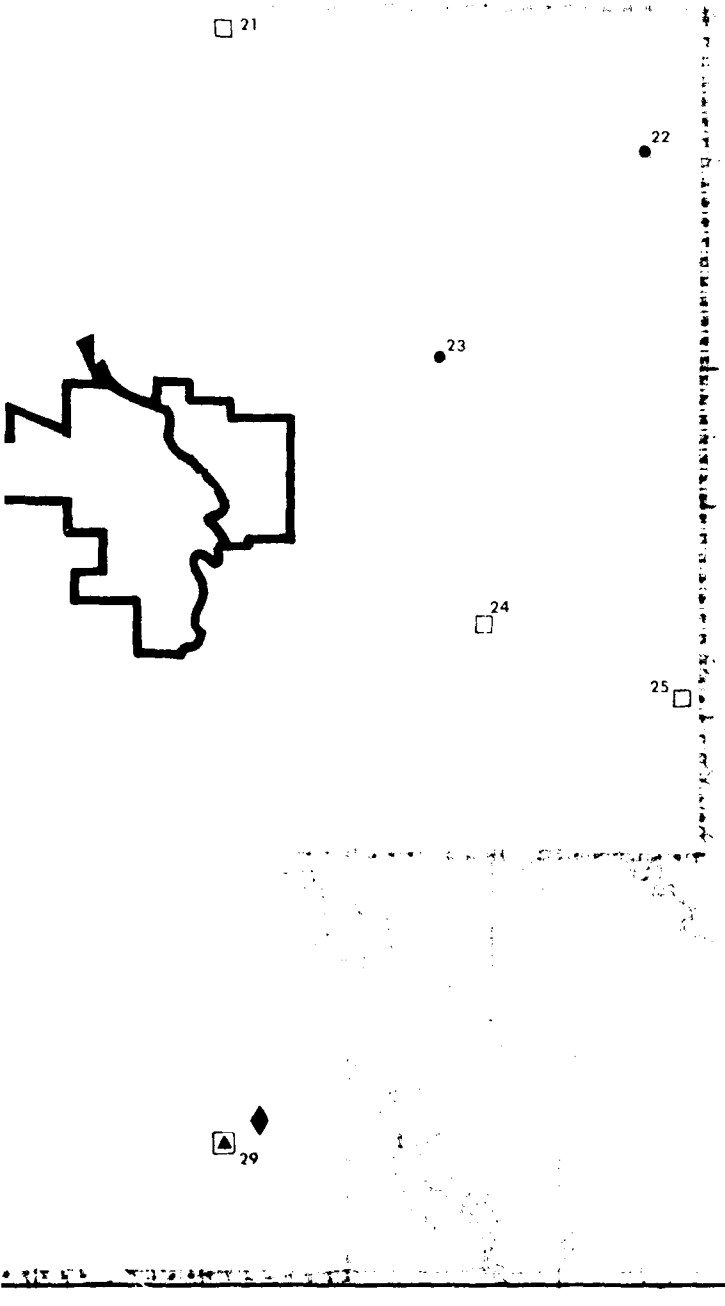
Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY



COMMUNITY FACILITIES
FOR RURAL AREAS

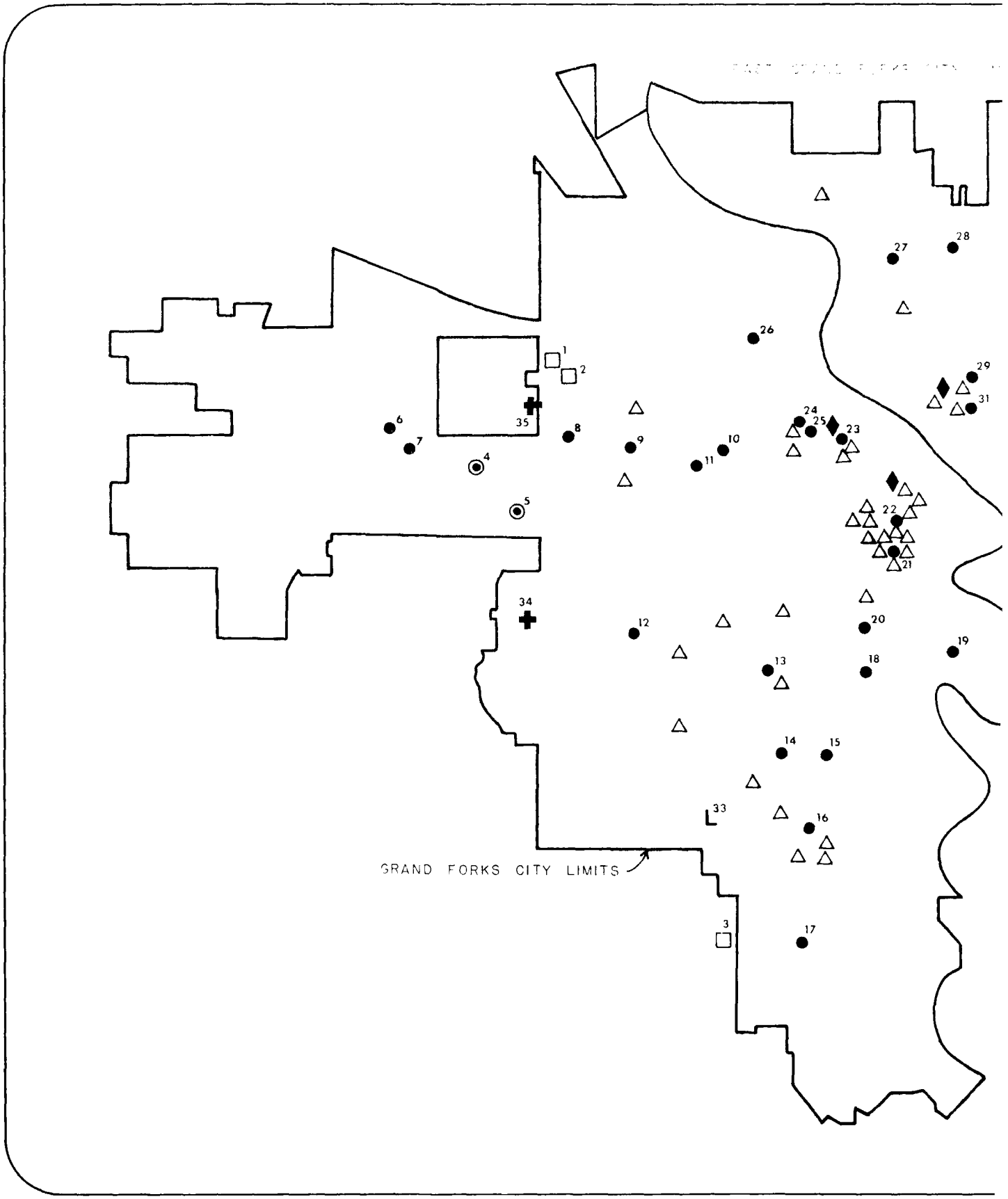
- ● ELEMENTARY, PAROCHIAL OR HIGH SCHOOL
- ▲ CHURCH
- □ CEMETERY
- ▣ CHURCH WITH CEMETERY
- ♦ TOWN HALL
- ✚ HOSPITAL

NOTE: SEE TABLE 58 FOR NUMBER LISTING OF RURAL CHURCHES, CEMETERIES AND SCHOOLS.

□ COMMUNITY FACILITIES FOR THE GRAND FORKS - EAST GRAND FORKS URBAN AREA PRESENTED ON PLATE 28

SOURCE: REFERENCES 119 THRU 123.

PLATE 27


GRAND FORKS CITY LIMITS
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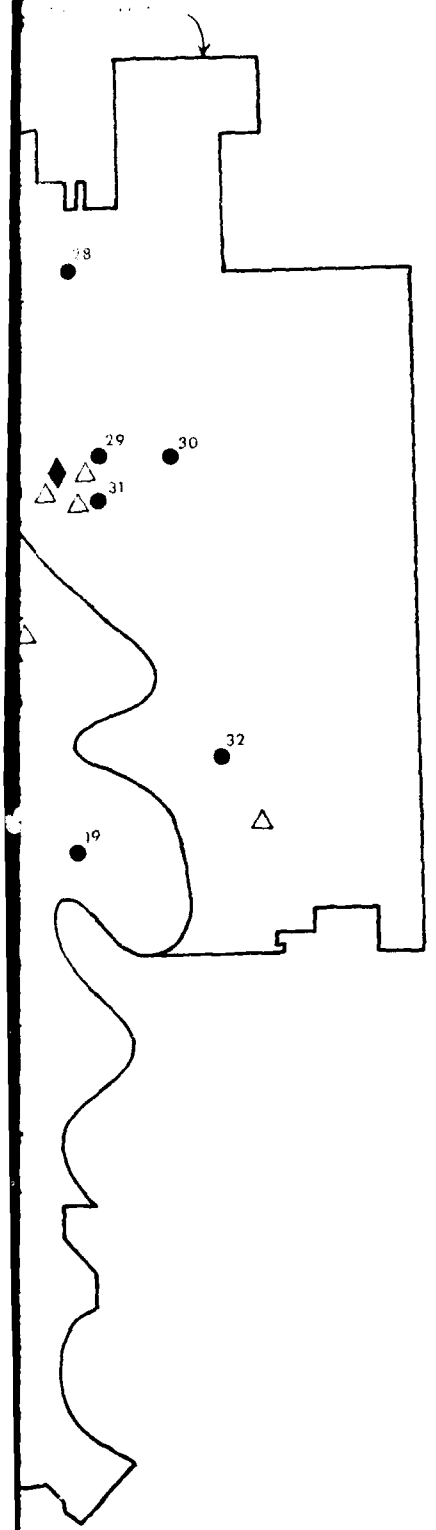

Grand Forks / East Grand
URBAN WATER RESOURCE

COMMUNITY FACILITIES FOR THE
GRAND FORKS – EAST GRAND F
URBAN AREA

◉ COLLEGES

● ELEMENTARY, PAROCHIAL
HIGH SCHOOL

△ CHURCH

□ CEMETERY

♦ COURT HOUSE OR CITY HA

✚ HOSPITAL

L LIBRARY

NOTE: SEE TABLE 58 FOR LISTING
GRAND FORKS – EAST GRAND FO
COMMUNITY FACILITIES AND SER

COMMUNITY FACILITIES IN RURAL
PRESENTED ON PLATE 27

SOURCE: REFERENCES 119 THRU 12

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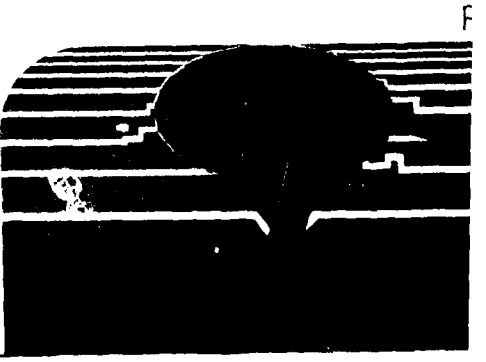


RECREATION

The major focus for metropolitan area recreational needs are the Red Rive North and Red Lake River floodplains and city park and recreation systems. Other a facilities include the Turtle River State Park near Arvilla, municipal parks at Thom Manvel, the County Fairgrounds at Grand Forks, school playgrounds, semipublic clubs in the urbanized area, and numerous privately owned and operated facilities d throughout the area (Plates 29 and 30). The lower 164 miles of the Red Lake Riv been designated by the State of Minnesota as a canoe route. The Red River from Lo Dam at Grand Forks to Pembina (139 miles) is identified in the North Dakot Comprehensive Outdoor Recreation Plan (SCORP) as a canoe route.

The Grand Forks park system commenced in the early 1900's with the acqui 150 acres of parkland at four locations (Reference 90). The present system (Refere consists of over 350 acres at 15 locations, as listed in Table 60. These parks inc community park (Lincoln Park), 3 sub-community parks, 2 special use areas inclu municipal golf courses, 6 neighborhood parks and 6 sub-neighborhood parks, all bu which are school playgrounds. These areas provide a wide variety of public sum winter recreation facilities, as shown by category in Table 60. A recent city park-us indicates that about 70 percent of the users originate in the city, about 20 percent within 25 miles, and 10 percent travel a distance of over 25 miles.

Complementing the recreational opportunities provided by the Grand Fo system are the County Fairgrounds, used for fair activities, rodeos and auto racin movie theaters; one drive-in movie; the Grand Forks Arena; and the Winter Sports the University of North Dakota. Numerous privately-owned facilities (see Table 61 aid in meeting recreational needs in the area.

The East Grand Forks park and recreation system presently includes about 164 acres of public and semipublic lands (Reference 128). Included are 3 neighborhood parks, 2 playground areas, 80 acres of mostly undeveloped floodway, and 30 acres of acquired but generally undeveloped property, as shown in Table 60. Facilities provided at each area are also shown by category in the Table. Complementing these city facilities are the school playgrounds and new civic arena, which provides a variety of indoor recreation facilities. Private recreation facilities, including a country club, rod and gun club and archery club, are also located in the city and are tabulated in Table 61.

The principal regional park serving the study area is the 486-acre Turtle River State Park, located about 25 miles west of Grand Forks near Arvilla. The park provides camping, picnicking, playground and swimming facilities, plus attractive natural areas for use by regional residents. The nearest regional Minnesota facility is the 285-acre Old Mill State Park, located about 47 miles northeast of East Grand Forks. The park contains a historic mill site and provides facilities for camping, picnicking, swimming and snowmobiling.

Municipal park and recreation areas outside the urbanized area include 2 parks totaling 15 acres at Thompson and a 10-acre park at Manvel. Facilities provided at these parks are also listed in Table 60.

Even with the relatively large number of recreational facilities in the area, both the Grand Forks and East Grand Forks park boards, statewide Comprehensive Outdoor Recreation Plans (SCORP's) and user surveys indicate needs for additional areas and facilities. These added facilities are needed to serve an expanding population with increased leisure time. To meet these needs, the 1974 Grand Forks Master Park and Open Space Plan recommends the addition of over 234 acres of parkland by 1990, development of a city bicycle-hiking trail system, colocation of neighborhood parks with existing or new elementary schools, and intensified management and use of existing facilities. The park-use survey made in support of the Plan indicated the greatest need for tennis and bike path facilities. Grand Forks presently has a LAWCON (Land and Water Conservation) Grant application pending for a recreational complex consisting of 6 tennis courts, 4 handball courts, 2 basketball courts and attendant parking. The April 1976 East Grand Forks Recreation

Facility Study recommends additional park areas both in the northern and southern sections of the city; a safe crossing of U.S. Highway 2; traffic controls for safe access to the Civic Recreation Center; development of bike routes and walking trails; development of a former landfill for recreational use; and water-based recreation facilities for aesthetic reasons and greater utilization of floodplain areas. The two greatest user needs, as indicated by a recent survey, are a north-end park and a safe crossing over U.S. Highway 2. A LAWCON Grant for recreational development of the O'Leary Park has recently been approved.

TABLE 60 [1]

PUBLIC PARKS AND RECREATION AREAS

Location	Name	Area in Acres	Type of Facilities: Archery Range	Baseball Diamond	Softball Diamond	Tennis Courts	Golf Course	Curling Area	Hockey Pen	Ice Rinks	Campgrounds	Picnic Grounds	Playground Equip.	Ski Toboggan Area	Swimming Pool	Recreation Room	Warming House	Horseshoe Courts	Boat Landing	Amphitheater	Flower Gardens	Toilets	Football	Snowmobiling
Grand Forks																								
Belmont & 23rd Ave. So.	Lincoln Park	124.10	X			X	X					X	X	X				X	X			X		
7th Ave. So.	Williamson Ball Field	15.85		X	X			X		X			X									X		
Park Ave. & N. 1st. St.	Riverside Park	38.59			X	X			X	X	X	X	X	X	X	X	X	X				X		
Elm Ave. & So. 4th St.	Central Park	19.01			X				X			X	X			X	X	X		X	X	X		
17th Ave. So. & So. 25th St.	Appolo Park	27.00		X	X																			
Univ. Ave. & No. 25th St.	University Park	18.20			X				X	X		X	X			X	X	X				X		
13th Ave. So. & So. 10th St.	Elk's Park	10.00			X				X	X			X		X	X	X	X						
11th Ave. So. & 20th St.	Franklin Park	10.00			X					X			X			X	X	X						
6th Ave. N. & N. 39th St.	Lake Agassiz Park	7.20								X														
Oak & 22nd Ave. So.	Cox Park	6.50			X				X	X			X			X	X	X						
9th Ave. So. & So. 15th St.	Wilmar Park	5.50			X				X	X			X			X	X	X						
	Ray Richards																							
Demers Ave.	Golf Course	70.00					X																	
Cherry St. & 42nd Ave.	Sunbeam (In 2-3 yrs)	18.7								Undeveloped														
	Medview (In 2-3 yrs)	9-10								Undeveloped														
	Mini-park	0.62								Undeveloped														
East Grand Forks																								
	Sherlock Park	20.5							>	X		X	X		X		X	U			X	X	U	
	Stauss Park	5.3							X	X		X	X					U				X	X	
	Folson Park	25.4	U						X	X		X	X				X	U	U			X	U	
	Harney Playground	1.12								X			X											
	Griggs Playground	2.0							X	X			X										X	
	O'leary Property	28.0										U	U										U	
	Lawonn Property	1.2																			X			U
	Floodway	60.0																	U					
	DDT'L Floodway	20.0										U	U						U		X		U	U
Thompson																								
	Heritage Park	10.0			X	X																		
	Recreation Area	5.0			X													X						
Manvel																								
	Ray Ronan Park	10.0			X				X			X						X						
Arvilla																								
	Turtle River State Park	486.0									X	X	X		X									

[1] Excluding school grounds and facilities

Sources: References G.F. Rec. Plan, EGF Rec. Plan, and N.D. SCORP

TABLE 61

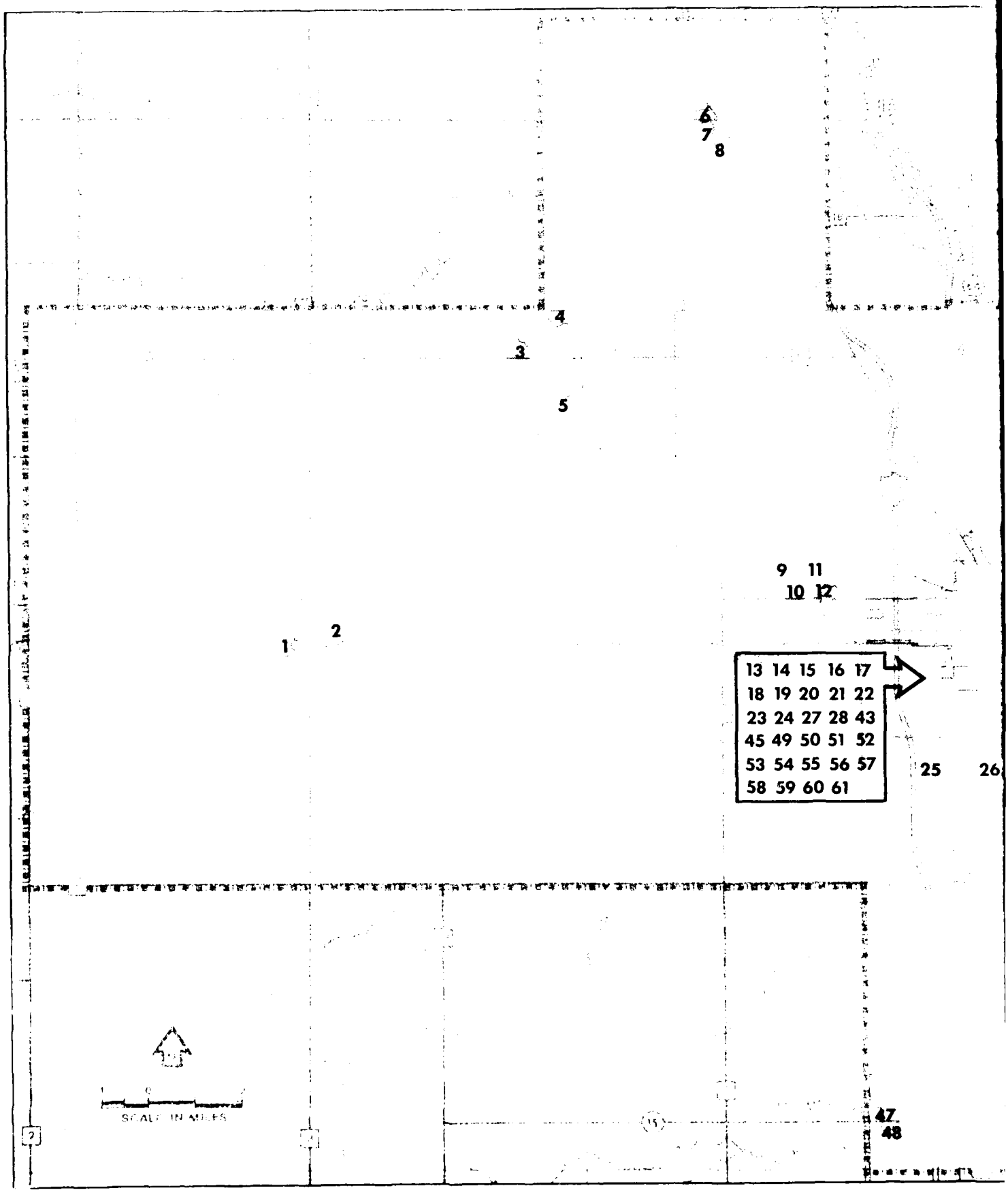
OTHER RECREATION FACIL

Map Number	Name or Type	Location
1	Playground, ball park	Emerado, N.D.
2	Amusement Center	Emerado, N.D.
3	Nat'l waterfowl production area	Blooming Township, N.D.
4	Picnic grounds	Blooming Township, N.D.
5	Kelly Slouth Nat'l Wildlife Refuge	Blooming Township, N.D.
6	Manvel-Gilby Gun Club	Manvel, N.D.
7	Monteray School & Stables	Manvel, N.D.
8	Roy Ronan Park	Manvel, N.D.
9	Amusement Center	Rye Township, N.D.
10	Westside Trailer Park and Campground	Rye Township, N.D.
11	Amusement Center	Rye Township, N.D.
12	Grand Forks Rod & Gun Club	Rye Township, N.D.
13	Drive-in movie	Grand Forks
14	University Park	Grand Forks
15	University of North Dakota Field House Memorial Stadium Winter Sports Center	Grand Forks
16	YMCA	Grand Forks
17	Roy Richards Golf Course	Grand Forks
18	Riverside Park	Grand Forks
19	County Fairgrounds	Grand Forks
20	Hylden Field	Grand Forks
21	Y-Family Center	Grand Forks
22	Apollo Park	Grand Forks
23	Park	Grand Forks
24	Elk's Park	Grand Forks
25	KOA Campground	Grand Forks Township, N.D.
26	Drive-in movie	Grand Forks Township, N.D.
27	Cox Park	Grand Forks
28	Central Park	Grand Forks

ABLE 61

REATION FACILITIES

	Map Number	Name or Type	Location
	29	Valley Country Club	East Grand Forks, Minn.
	30	River Heights Park	East Grand Forks, Minn.
	31	East Grand Forks Rod & Gun Club	East Grand Forks, Minn.
	32	River Heights Elementary School	East Grand Forks, Minn.
	33	Red River Archers	East Grand Forks, Minn.
	34	Sherlock Park	East Grand Forks, Minn.
	35	River Bend Country Club	East Grand Forks, Minn.
	36	Valley Elem. School Grounds	East Grand Forks, Minn.
	37	Folson Park	East Grand Forks, Minn.
	38	Crestwood Elem. School Grounds	East Grand Forks, Minn.
	39	Stauss Park	East Grand Forks, Minn.
	40	Harney Park	East Grand Forks, Minn.
	41	Griggs Park	East Grand Forks, Minn.
	42	Civic Recreation Center	East Grand Forks, Minn.
	43	Lincoln Park	Grand Forks
	44	Winston Register Stables	Grand Forks
	45	George Eastburn Stables	Grand Forks
	46	Grand Forks Country Club	Grand Forks Township
	47	Thompson Recreation Area	Thompson, N.D.
	48	Heritage Park	Thompson, N.D.
	49	Grand Forks Arena	Grand Forks
	50	Williamson Ball Field	Grand Forks
	51	Franklin Park	Grand Forks
	52	Lake Agassiz Park	Grand Forks
	53	Wilmar Park	Grand Forks
	54	Indoor Tennis Arena	Grand Forks
	55	Roller Rink	Grand Forks
	56	Wilder School Playground	Grand Forks
.D.	57	Roosevelt School Playground	Grand Forks
.D.	58	Belmont School Playground	Grand Forks
	59	Lincoln School Playground	Grand Forks
	60	West School Playground	Grand Forks
	61	Mini-park Playground	Grand Forks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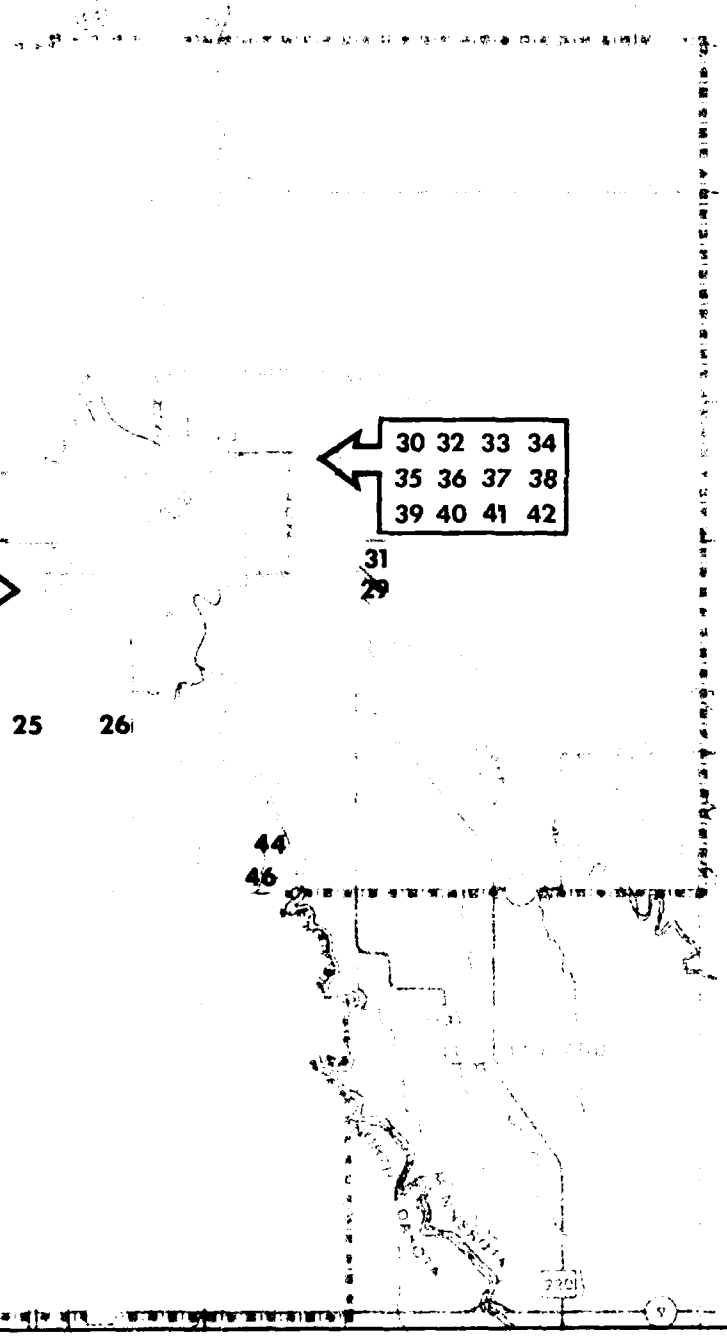
SCALE IN MILES



Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

RECREATION FACILITIES
FOR RURAL AREAS

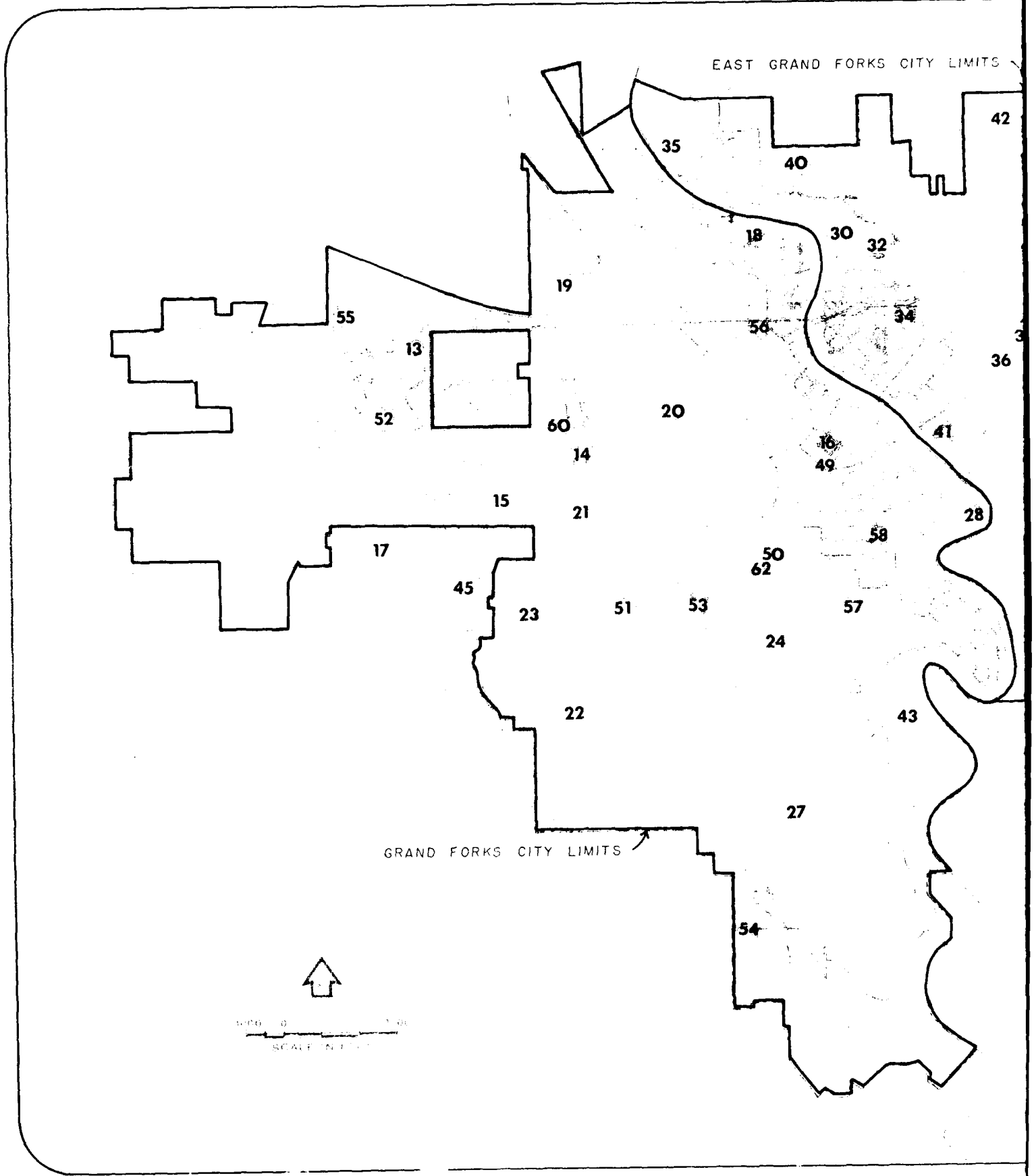
5 RECREATION FACILITY

LOCATION OF GRAND FORKS – EAST GRAND FORKS RECREATION FACILITIES SHOWN ON PLATE 30

NOTE: SEE TABLE 61 FOR NUMBER LISTING OF RECREATION FACILITIES

SOURCE: REFERENCES 119 THRU 130

PLATE 29


EAST GRAND FORKS CITY LIMITS
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GRAND FORKS CITY LIMITS
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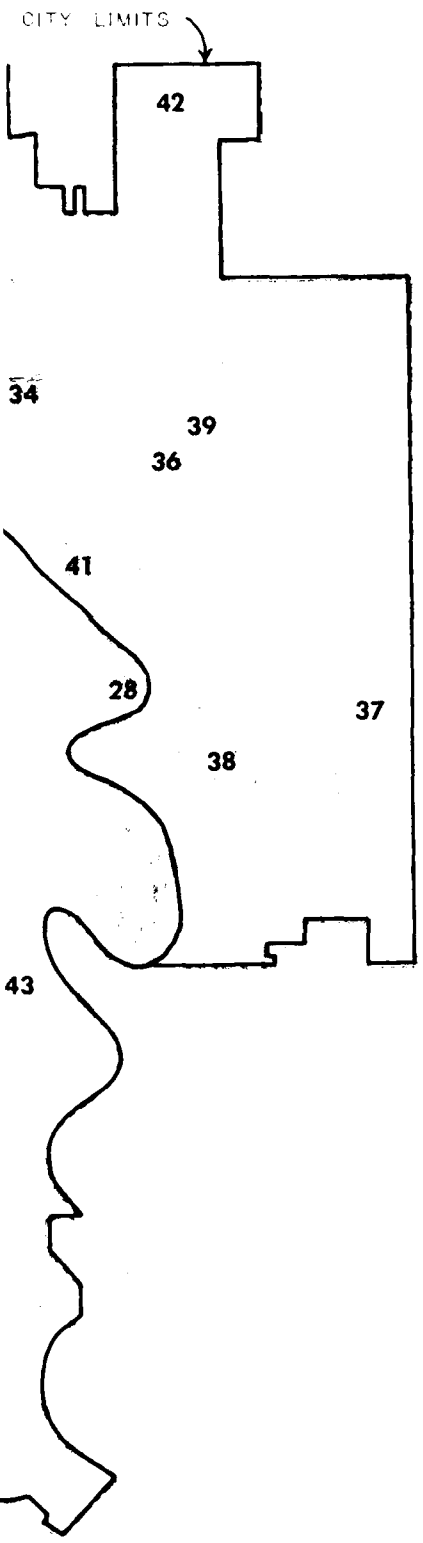


Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

RECREATION FACILITIES FOR THE GRAND FORKS - EAST GRAND FORKS URBAN AREA

36 RECREATION FACILITY

RECREATION FACILITIES IN RURAL AREAS PRESENTED ON PLATE 29

NOTE: SEE TABLE 61 FOR NUMBER LISTING OF RECREATION FACILITIES.

SOURCE: REFERENCES 119 THRU 130.

PLATE 30

TABLE 62

RECREATION FACILITY REQUIREMENTS - REGION I, MINNESOTA

Facility	1972 Existing		Region I 1980 Required		Region I 1990 Required	
	Region I	Polk County	Quantity	Need or Surplus (+)	Quantity	Need or Surplus (+)
Athletic Fields (acres)	342	54	353	(-11)	363	(-21)
Tennis Courts	32	15	42	(-10)	36	(-4)
Golf Courses (holes)	135	36	66	(+69)[1]	---	
Picnic Tables	701	211	887	(-186)	892	(-191)
Campsites	391	151	913	(-522)	1112	(-721)
Hiking Trails (miles)	27	5	91	(-64)[1]	---	
Snowmobile Trails (miles)	82	5	464	(-382)[1]	26 miles per 1000 added vehicles	
Biking Trails (miles)	---	3	---	---	---	---
Swimming Area (1000 ft^2)	196	14.4	310	(-114)	336	(-140)
Canoe Stream (miles)	164	---	13	(+151)	18	(+146)

1. 1975 Requirements

Source: 1974 Minnesota SCORP

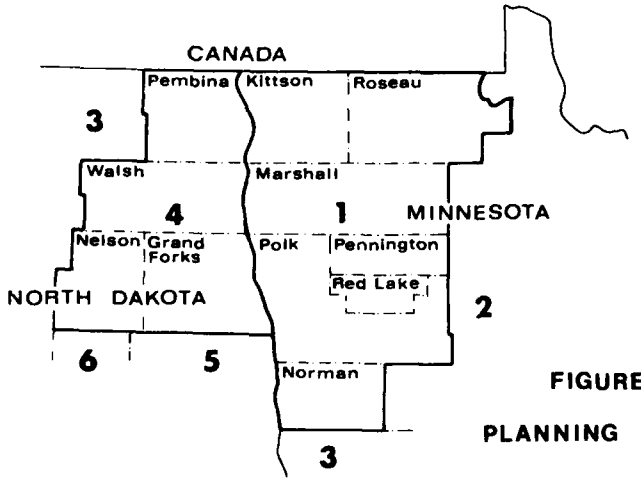


FIGURE 17

PLANNING REGIONS

On a regional basis, both the Minnesota and North Dakota State Outdoor Recreation Plans (SCORP) indicate a need for various recreation facilities. For Minnesota Region I, the 7-county area including Polk County (see Figure 17), the Minnesota SCORP indicates a 1980 need for all listed facilities except additional golf courses and canoe stream, as shown in Table 62. For the northeastern region (Region 4) of North Dakota, including Grand Forks County, the North Dakota SCORP indicates a future surplus or need for selected recreation facilities as shown in Table 63.

TABLE 63

RECREATION FACILITY REQUIREMENTS - REGION 4, NORTH DAKOTA

Facility	Existing Region 4	Grand Forks County	Region 4 - 1980 Add'l Required	Region 4 - 1990 Add'l Required
Baseball & Softball Diamonds	51	36	28	34
Tennis Courts	22	13	40	60
Golf Courses (9 hole courses)	15	7	8	14
Picnic Tables	726	385	442	525
Campsites	229*	310	61	108
Hiking Trails (miles)	---	53	---	---
Snowmobile Trails (miles)	0	0	---	---
Biking Trails (miles)	0	0	12	14
Swimming Area (pools)	14	6	2	2
Canoe Stream (miles)	Red River	Red River	Not Determined	Not Determined
Ice Skating Rinks	18	8	12	15
Horseshoe	44	30	Not Determined	Not Determined
Playgrounds	23	2	Not Determined	Not Determined

*

Source: Reference 124

KEY REFERENCES

North Dakota State Outdoor Recreation Agency, **1975 North Dakota State Comprehensive Outdoor Recreation Plan**, Mandan, North Dakota, July 1976

Minnesota Department of Natural Resources, **Minnesota State Comprehensive Outdoor Recreation Plan - 1974**, St. Paul, Minnesota

University of North Dakota, **Grand Forks Master Park and Open Space Plan**, Bureau of Governmental Affairs, Grand Forks, 1974

Wehrman, Chapman Associates, Inc., **Polk County Recreation and County Facilities**, Minneapolis, Minnesota, 1970

Neu, Steven M., **East Grand Forks Recreation Facilities Study**, Recreation Administration, University of North Dakota, Grand Forks, April 1976

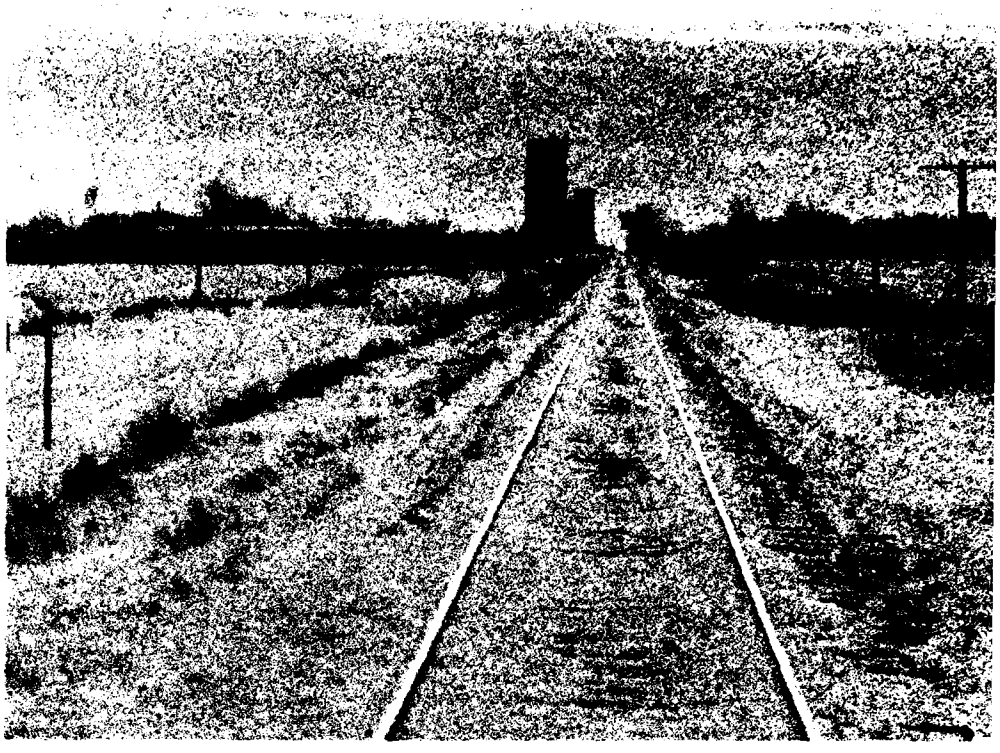
TRANSPORTATION AND UTILITIES

An adequate transportation system is essential if a community Grand Forks-East Grand Forks vicinity is fortunate in that transport provided early in the communitys' history and have continued to dev paragraphs describe the various modes of transportation available to st

Air transportation within the area is facilitated primarily by Grar al Airport (Class A), located 4-1/2 miles from the city. Northwest Or and Frontier Airlines provide 32 flights a day to and from Grand Forks, jet flights. Connections are readily available from Grand Forks Inte major Canadian and United States cities, as well as to the North Dakot Fargo, Jamestown, Minot and Devils Lake. In addition to passenger serv available via air freight or air express to Bismarck, Devils Lake, Dicki town, Minot and Williston. Other air facilities in the area include the Gr Base and a small landing strip at Manvel. However, the Air Base is a mi is not normally considered a public transportation facility.

Both passenger and freight rail services are available to area resi shipments are handled by Burlington Northern, Inc., and daily passer surrounding region, via the Empire Builder, is handled by the Amtral Forks. Various trucking services are provided to the area by both local a companies.

Bus service to the area is provided by three bus lines. Greyhoun between Grand Forks and the cities of Fargo, North Dakota, and Winr Highway 2 Express operates between Grand Forks and Minot, North D Bus Lines operates between Grand Forks and Bemidji, Minnesota.



Grand Forks is located at the junction of U.S. Highways 81 and 2. Interstat I-29 parallels U.S. Highway 81 and connects the study area to both the Ca Mexican borders. The major junction within East Grand Forks is U.S. High Minnesota State Highway 220. For relative locations of highway, rail and air trar facilities, see Plate 31.

The major planned highway modification in the urbanized area is th replacement of the State Highway 220 bridge over the Red Lake River in East G Unstable soil conditions are causing the north abutment to subside. Various alter under joint consideration by the city and State Highway Department. Other planned improvements, all in Grand Forks and/or Grand Forks County, include U.S. Highway 2 to 4 lines (west of the U.S. Air Base); widening and other impr Columbia Road; and a proposed extension of the city "Ring" Road north of Dem The Grand Forks City Street and Highway Plan is presently being updated by a jo the city and the North Dakota State Highway Department.

Electric power transmission line and generating plant locatio
Plate 31. Within the study area, four electrical power agencies suppl
area residents. They are the United Power Association (UPA);
Cooperative (MPC); the U.S. Bureau of Reclamation (USBR); ar
Power Company (NSP). All of the major electrical systems are inter
power grid. Future area electric power needs are presently being
studies of additional regional system interconnections, added capaci
other main stem damsites, and plant expansions planned or under v
utilities. Electric power for East Grand Forks residents is provided
Grand Forks Water and Light Department.

A 16-inch pipeline transmits crude oil into the study area from
of Grand Forks. Another general purpose petroleum products pipeli
to Grand Forks users. Northern States Power Company provides nat
Grand Forks area customers.

Telephone service to the area, including the Air Force Base, is provided by Northwestern Bell Telephone Company. Total capacity is over 26,000 instruments, with a reported excellent capability for expansion. A discussion of area wastewater and water supply systems was given in the Water Resources section of this report.

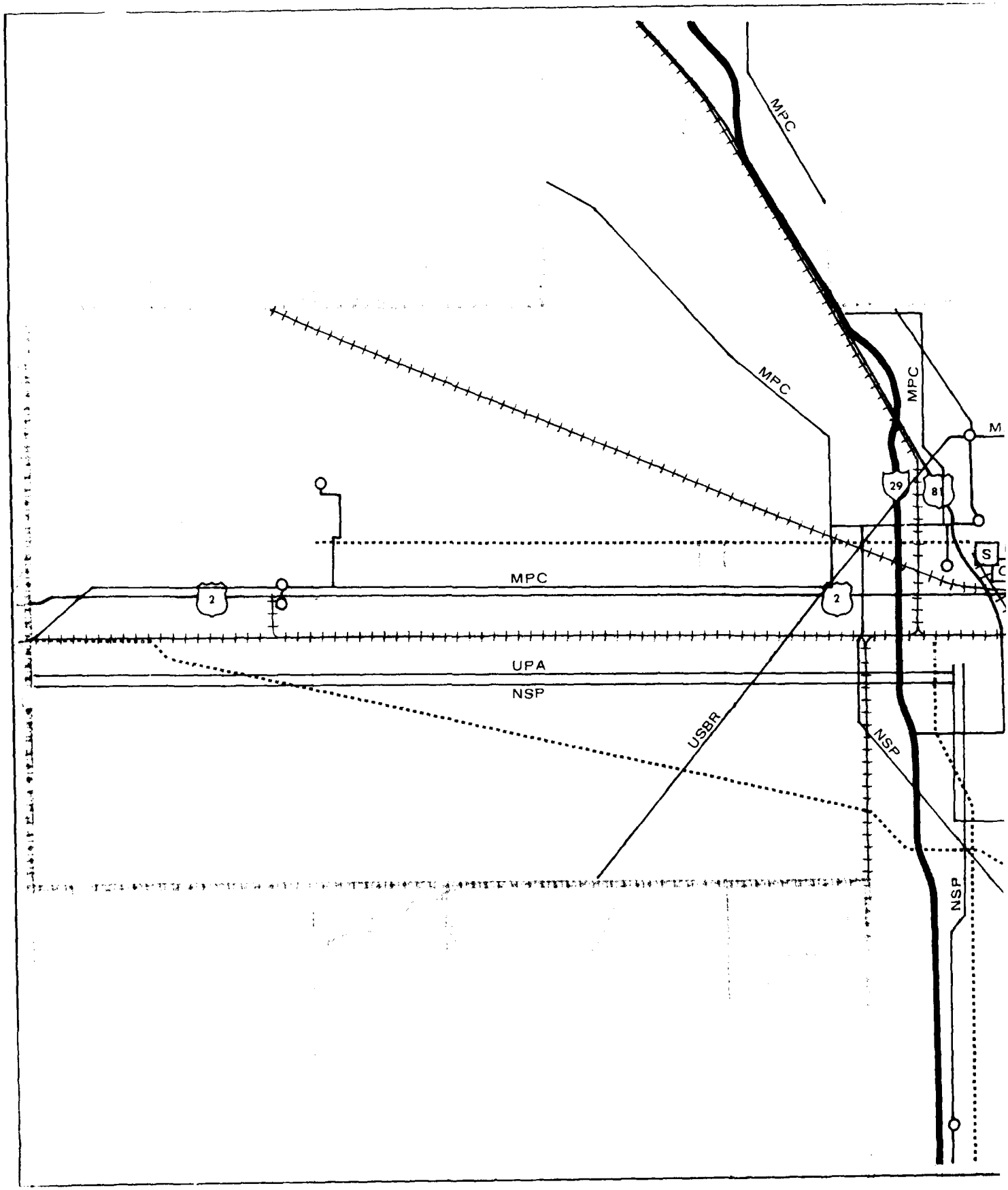
KEY REFERENCES

Industrial Development Commission, **Local Transportation, Transportation, and Utilities,** Grand Forks, 1976

Northwestern Regional Development Commission, **Region I Development Guide, Phase I, Data Collection and Interpretations,** Crookston, Minn., June 1976

Grand Forks Chamber of Commerce, **Your Introduction to Grand Forks,** Grand Forks, North Dakota

East Grand Forks Chamber of Commerce, **Economic Facts Booklet,** East Grand Forks, Minn., 1976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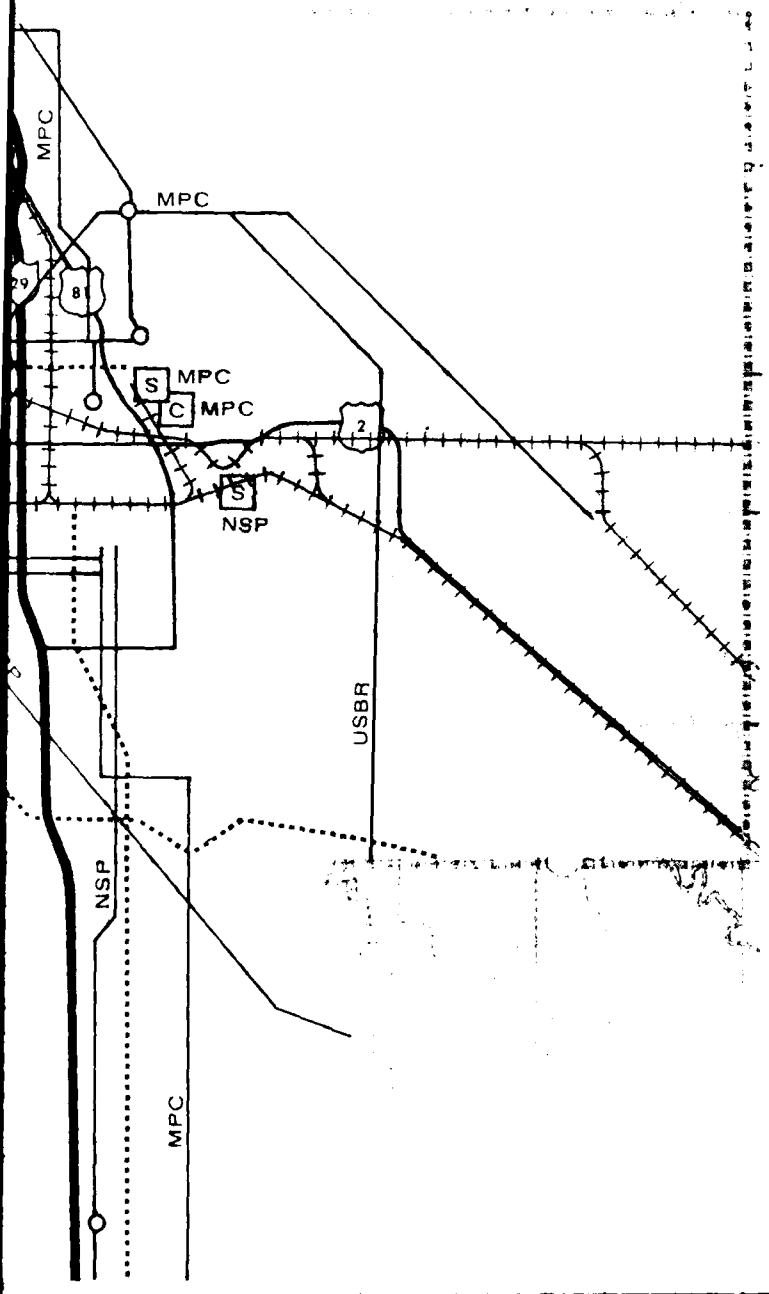

Grand Forks / East Grand Forks
URBAN WATER RESOURCES STUDY

- INTERSTATE HIGHWAY
- U.S. HIGHWAY
- RAILWAYS
- MINOR AIRSTRIP
- MAJOR AIRPORT
- [S] STEAM POWER PLANT
- [C] INTERNAL COMBUSTION POWER PLANT
- OIL PIPELINE
- O POWER SUBSTATION
- POWER TRANSMISSION LINE

MPC	MINNKOTA POWER COOP. INC.
UPA	UNITED POWER COOP.
NSP	NORTHERN STATES POWER
USBR	U.S. BUREAU OF RECLAMATION

SOURCE: REFERENCES 48,119,120,131.

PLATE 31

REFERENCES TO PHYSIOGRAPHIC ELEMENTS

1. North Dakota Geological Survey, **Geology and Ground Water Resources of Grand Forks County**, Part I - Geology, Bulletin 53, 1970
2. North Dakota Geological Survey, **Geology and Ground Water Resources of Grand Forks County**, Part II - Ground Water Basic Data, Bulletin 53, 1970
3. North Dakota Geological Survey, **Geology and Ground Water Resources of Grand Forks County**, Part III - Ground Water Resources, Bulletin 53, 1970
4. Sims, P. K., and Morey, G. B., **Geology of Minnesota: A Centennial Volume**, Minnesota Geological Survey, 1972
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Contact Was Made With The Following Individuals and Organizations

176. Kannowski, P., Dr., Institute for Ecological Studies, University of North Dakota, Grand Forks
177. Seabloom, R., Dr., Biology Department, University of North Dakota, Grand Forks
178. Grandahl, C. R., Chief Game Management Section, North Dakota State Department of Conservation
179. Schroeder, C., Waterfowl Biologist, North Dakota Department of Conservation
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187. Schultz, D., Director of Engineering, North Dakota State Water Commission
188. Braun, B., Design Engineer, North Dakota State Water Commission
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190. Swanson, R., Chief Design Engineer, North Dakota State Water Commission
191. Ripley, D., Ground Water Geologist, North Dakota State Water Commission
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193. Bushfield, R., City Planner, Grand Forks, North Dakota
194. LeClerc, R., Acting City Planner, Grand Forks, North Dakota
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203. Wranger, J., Director, Red River Regional Development Countil, Grafton, North Dakota
204. Dickie, A. B., County Planner, Grand Forks County, North Dakota
205. Nelson, R., Executive Director, Grand Forks Industrial Development Commission
206. La Grave, R., Director, Grand Forks Community Development & Housing Authority
207. Abbot, H., Superintendent, Grand Forks Park and Recreation Department
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209. Rhode, J., Assistant Superintendent, East Grand Forks City Schools
210. Thorkelson, D., North Dakota Department of Economic Development
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213. Mazac, H., Mayor, Emerado, North Dakota
214. Forester, S., Mayor, Manvel, North Dakota
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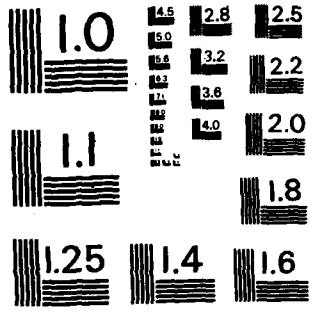

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222. Minnesota Geological Survey, Minneapolis, Minnesota
223. Assistant District Engineer, Department of Highways, Grand Forks, North Dakota
224. Minnesota Historical Society, St. Paul, Minnesota
225. Superintendent of Schools, Grand Forks County, North Dakota
226. Anderson, C., Engineer, Red Lake Watershed District, Crookston, Minnesota
227. Daley, J., Fish Section, Minnesota Department of Natural Resources
228. Regan, R., Regional Planner, Upper Mississippi River Basin Commission
229. Gibson, J., Bureau of Planning, Minnesota Department of Natural Resources
230. Department of Geography, University of North Dakota, Grand Forks, North Dakota
231. Murdock, S., Dr., North Dakota State University, Fargo, North Dakota
232. Grand Forks International Airport, Grand Forks, North Dakota
233. Crawford, R., Dr., Biology Department, University of North Dakota, Grand Forks
234. Wolfe, Terry, Area Biologist, Minnesota Department of Natural Resources, Crookston, Minnesota
235. Blice, Jim, North Central Forest Research Station, St. Paul, Minnesota
236. District Conservationist, U.S. Soil Conservation Service, Grand Forks
237. Kuehn, Jerome, Minnesota Department of Natural Resources, St. Paul, Minnesota
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SPECIAL PHOTO CREDITS

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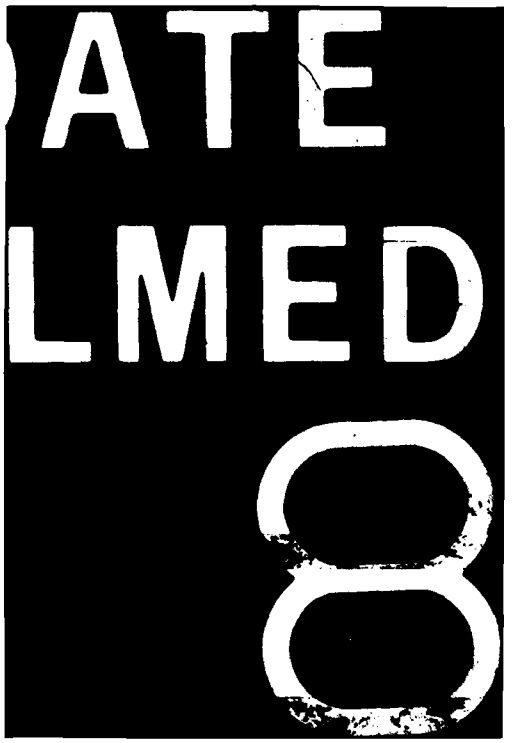
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